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Effect of Guard Band Reduction on Marker Beacon Receiver Performance

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July 1992

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16. Abstract

Aircraft Marker Beacon Receivers, which are a part of the Instrument Landing System, operate at a frequency of 75 megahertz (MHz) and until January 1, 1990, were protected by a guard band of +/- 400 kilohertz (kHz). After this date, the guard band was reduced to +/- 200 kHz.

This report details testing performed at the Federal Aviation Administration (FAA) Technical Center to assess the effect emitters, using this new guard band, will have on Marker Beacon Receivers. The effect of the interference on the Marker Beacon Receivers was determined by performing a desensitization test, a no-desired signal test, and a selectivity measurement on five general aviation Marker Beacon Receivers. For these tests, emitters that use amplitude modulation, frequency modulation, pulse modulation, and continuous wave were simulated.

It was found that emitters using these new frequencies can cause interference to Marker Beacon Receivers. Recommendations for limiting the interference effect are provided in the body of the report.

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EXECUTIVE SUMMARY

Until December 31, 1989, the 75-megahertz (MHz) Instrument Landing System Marker Receiver was protected by a 74.6 to 75.4 MHz guard band. After this date, the guard band was reduced by 400 kilohertz (kHz) and now extends from 74.8 to 75.2 MHz.

The Federal Communications Commission (FCC) is proposing 10 frequencies in the new 74.6 to 74.8 MHz band and 10 in the new 75.2 to 75.4 MHz band. These new frequencies, with 10-kHz spacing, would be used by low power Part 90 emitters and Part 15 Auditory Assistance devices. The Part 90 equipment would be permitted to radiate 1 watt (W) maximum and the Auditory Assistance devices 0.0012 W maximum in these new frequency bands.

At the request of Washington Headquarters, Spectrum Engineering Division, ASM-500, the Federal Aviation Administration (FAA) Technical Center performed bench tests to determine what effect low power emitters operating with a reduced guard band have on aircraft Marker Receivers.

The tests were divided into three parts: desensitization tests, no-desired signal tests, and selectivity measurements. The desensitization test simulates an aircraft receiving an FAA Marker Beacon facility and the interference simultaneously. This could occur if the interference source is located near the Marker Beacon facility. The no-desired signal test investigated the possibility of a false Marker occurring due to the interference. This could occur if the aircraft was receiving interference but was not over the Marker Beacon. Finally, the selectivity was measured to determine the off frequency signal rejection characteristics of the Marker Receiver.

Four different modulation types were used for the interference: Amplitude Modulation, Frequency Modulation, Pulse Modulation, and Continuous Wave (i.e., no modulation).

Five general aviation Marker Receivers were used for these tests. The interference effect was quantified by measuring and observing both the Marker Receiver tone and lamp indications.

The following are conclusions from these tests:

1. Part 90 devices operating at 1 W maximum in these new bands can degrade Marker Receiver performance. Auditory Assistance devices operating at 0.0012 W maximum in these new bands would not affect Marker Receiver performance.

2. Pulse Modulation type interference effected all five receivers.

3. Pulse Modulation type interference significantly effected three of the five Marker Receivers tested.

4. The interference can cause a false Marker to occur.

5. Selectivity measurements indicate that Marker performance cannot be predicted based on selectivity alone.

Based on these tests, the following recommendations are made:

1. Part 90 device antennas should be vertically polarized to maximize cross polarization isolation with Marker Receiver antennas.

2. They should be located at least 2000 feet from any aircraft approach path.

3. Frequency Modulated (FM) or Continuous Wave (CW) modulation should be used since they caused the least interference of the four modulation types tested.

4. Pulse Modulation (PM) should not be used in these bands. PM affected all the Marker Receivers tested.

5. The equipment shall transmit the minimum power required to perform its function and shall not exceed 1 W.

INTRODUCTION

PURPOSE.

The purpose of this effort is to determine what effect low power emitters operating in the 74.6 to 74.8 and 75.2 to 75.4 megahertz (MHz) bands have on the 75-MHz Aviation Marker Beacon Receiver.

BACKGROUND.

Until December 31, 1989, the 75-MHz Marker Receiver was protected by a 74.6 to 75.4 MHz guard band. After this date the guard band was reduced by 400 kilohertz (kHz) and now extends from 74.8 to 75.2 MHz. The Federal Communications Commission (FCC) has recently issued a Notice of Proposed Rule Making (Amendment of Part 90 to Increase the Number of Frequencies in the 72-76 MHz Band for Low-Power Mobile Use, PR Docket No. 91-295) in which they propose 10 frequency assignments in the new 74.6 to 74.8 MHz band and 10 in the new 75.2 to 75.4 MHz band. They will be spaced 20 kHz apart.

The FCC has also issued a draft Report and Order (Amendment of Part 15 to Provide Additional Frequencies for Auditory Assistance Devices for the Hearing Impaired, ET Docket No. 91-150) in which they plan to permit the use of these new frequency bands by Auditory Assistance Devices.

This guard band reduction which freed up 20 frequencies for low power (1 watt (W) or less) commercial use, also increased the possibility of interference to Marker receivers. The Federal Aviation Administration (FAA) Technical Center was tasked by Washington Headquarters, Spectrum Engineering Division, ASM-500, with determining what effect low power emitters operating with a reduced guard band have on aircraft Marker Receivers.

This report details the testing that was performed. These tests were based on requirements and procedures found in United States Standard Flight Inspection Manual OAP 8200.1, Section 219 "75 MHz Marker Beacon" and RTCA Document DO-143, "Minimum Performance Standards - Airborne Radio Marker Receiving Equipment Operating on 75 Megahertz."

TEST DESIGN

APPROACH.

Two tests, which simulate the interference conditions an aircraft may encounter on approach, were performed. The first test was a desensitization test which simulates an aircraft receiving an FAA Marker Beacon facility and the interference simultaneously. This could occur if the interference source is located near the Marker facility. The second test investigated the possibility of a false Marker occurring due to the interference. This could occur if the aircraft was receiving interference but was not over the Marker beacon. This will be referred to as the no-desired signal test. In addition, the selectivity was also measured to determine the off frequency signal rejection characteristics of the receiver.

A computer analysis of the proposed new frequencies revealed that they would not combine with themselves or adjacent TV band frequencies to form a two frequency, third order intermodulation product near 75 MHz. In addition, previous tests on communications and VOR/Localizer receivers have shown that third order intermodulation interference is a factor only if the interferers are close to the desired frequency and at a high signal level. Therefore, two frequency, second order intermodulation products were also not considered significant because the new frequencies are low power (1 W maximum) and the second frequency would be at approximately 150 MHz.

For these two reasons, the effect of intermodulation interference on Marker Receivers was not measured.

These automated tests were performed on five Marker Receivers at the FAA Technical Center, in the building 176 lab. For these tests, the desired signal was a 1700-microvolt (μV) (-42 dBm), 75-MHz Radio Frequency (RF) signal which is the minimum RF signal level necessary to satisfy FAA commissioning and periodic Flight Inspection requirements. This signal was amplitude modulated 95 percent by either a 400-, 1300-, or 3000-hertz (Hz) tone. The 400-Hz tone is used to test the Outer Marker (OM) function; the 1300-Hz tone is for the Middle Marker (MM) function; and the 3000-Hz tone is for the Inner Marker (IM) function. This was the RF signal used to determine baseline performance of the Marker Receiver and as the desired signal when the interference is present.

DESENSITIZATION TEST.

For the desensitization tests, interferer F1 was 74.79 MHz and interferer F2 was 75.21 MHz. These two frequencies are +/- 10 kHz from the edges of the new guard band and will be the closest operational frequencies to the 75 MHz Marker Receiver. By using two interferers, it was possible to simulate interference below the Marker guard band, interference above the Marker guard band, and interference that was simultaneously above and below the Marker guard band.

The desensitization effect was measured by recording the audio and lamp on/off voltages of the Marker Receiver. The audio voltage was used to calculate the Signal-Plus-Noise to Noise ((S+N)/N) ratio (see figure 1).

Distance from the interferers was simulated by varying F1 and/or F2 in 5-decibel (dB) steps from -40 decibels above 1 milliwatt (dBm) to -15 dBm and in 1-dB steps from -15 dBm to 0 dBm.

Since the FCC proposal does not specify a modulation type, these tests used the following types which were considered to be the most likely possibilities:

1. F1 and/or F2 were Amplitude Modulated (AM) 90 percent with a 400-, 1300-, or 3000-Hz tone, as appropriate. (For example, when testing the Marker Receiver in its middle Marker mode, both the desired and the interferer(s) were modulated by 1300-Hz tones.)

2. F1 and/or F2 were Frequency Modulated (FM) +/- 15 kHz with 400-, 1300-, or 3000-Hz tone, as appropriate.

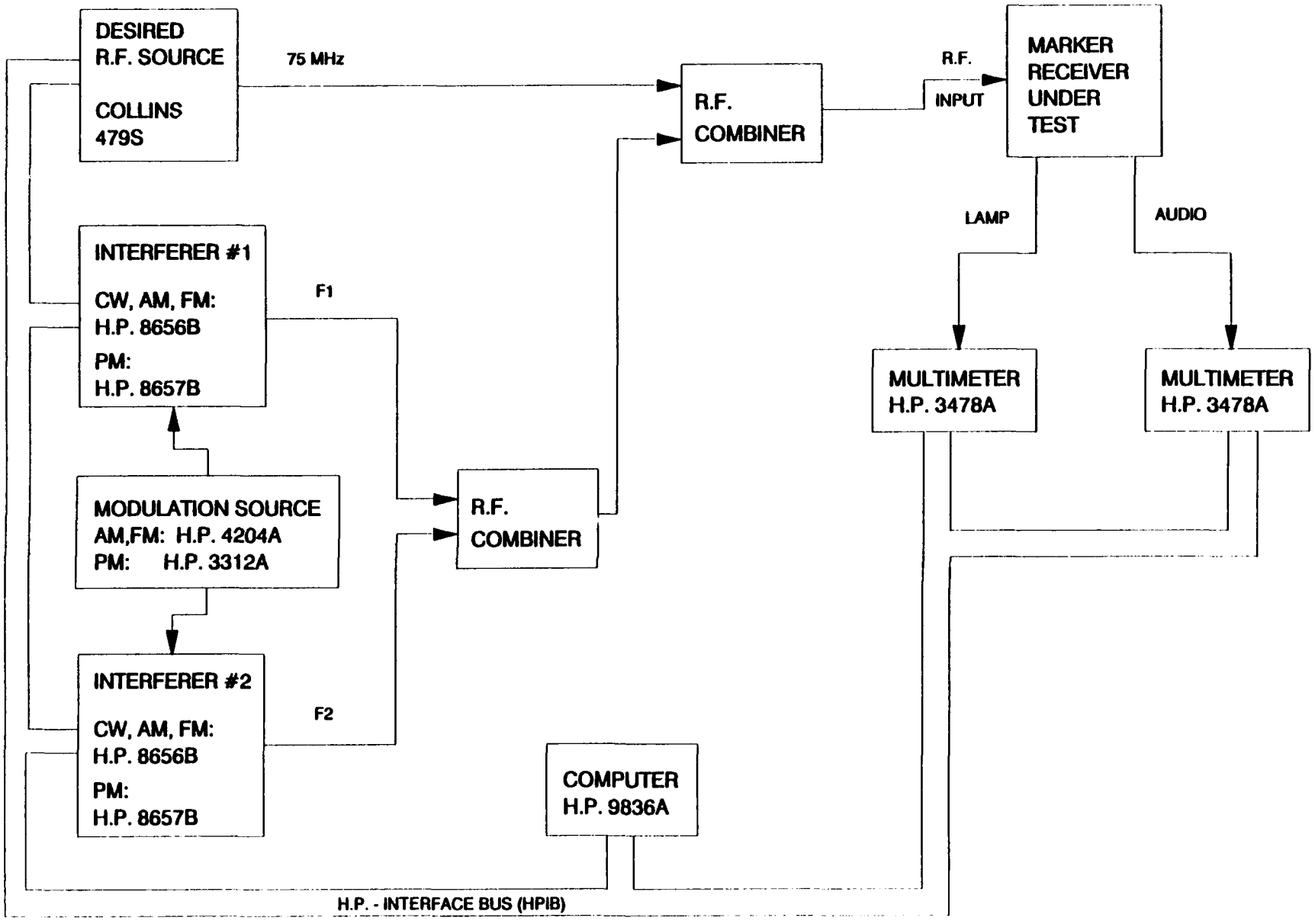

FIGURE 1. DESENSITIZATION AND NO-DESIRED SIGNAL TEST CONFIGURATION

. F1 and/or F2 were Pulse Modulated (PM) by a pulse with a Pulse Repetition requency (PRF) of 400, 1300, or 3000 Hz, as appropriate. This produced pulse idths of 1250, 384, and 166 microseconds (μs), respectively.

. F1 and/or F2 were Continuous Wave (CW).

o-Desired Signal Test. The no-desired signal test uses the same test setup, odulation types (except CW), and interfering levels as the desensitization test. ince this test does not use the desired signal, the interference effect could not e measured using the (S+N)/N ratio. However, it could be evaluated by observing he lamp indication and listening for audible interference.

electivity Measurements. Selectivity measurements used only the desired signal nd were performed manually. See figure 2 for the test setup.

TCA Document DO-143 Requirements. Marker Receivers used in the United States must eet Category B requirements of DO-143 which means (among other things) the eceiver's threshold sensitivity is set to Low (1000 μV). Marker Receivers, owever, are designed to also meet the Category A requirements (European-editerranean area) which have both a High (200 μV) and the Low setting. The High etting is used for enroute operations.

eceiver 1 had only a High and an Auto setting. Its Auto setting provided the Low ensitivity but it also automatically muted the audio allowing insufficient time to easure the audio signal. Therefore, in these tests, receiver 1 used the High ensitivity setting which was not automatically muted. This, however, created a arger margin between the 1700 μV desired signal and the 200 μV minimum sensitivity hich may produce test bench data that is different from operational use. eceivers 2, 3, 4, and 5 were tested using the Category B Low sensitivity mode.

ategory B equipment does not have a specific selectivity criteria but is instead equired to reject certain spurious emissions caused by frequencies that are not in hese new bands. Category A equipment is required to be 40 dB down at +/- 200 Hz., i.e., the skirts of the new 74.8 to 75.2 MHz guard band frequencies.

EST PROCEDURES.

esensitization Test. The desensitization tests used the (S+N)/N ratio and lamp n/off voltage measurement to evaluate the Marker Receiver's ability to detect the esired signal in the presence of interference.

he desensitization tests started with the desired signal turned on and the nterference turned off to establish a baseline measurement of the Marker eceiver's (S+N)/N ratio and lamp voltages. This was followed by (S+N)/N easurements of the desired signal with interferers F1 and F2 on; interferer F1 on nd F2 off; and interferer F1 off and F2 on. For each of these interference onditions, the lamp on/off voltages and the point where the interference became udible were also recorded. These tests were performed for each Marker onfiguration, i.e., OM, MM, and IM.

o-Desired Signal Test. The no-desired signal test began with a baseline easurement of the (S+N)/N ratio, using the desired signal only, to confirm proper eceiver performance. The desired signal was then turned off and the interference urned on. Audio and lamp indications were noted at each interfering signal level or F1 and F2 on, F1 on and F2 off, and F1 off and F2 on.

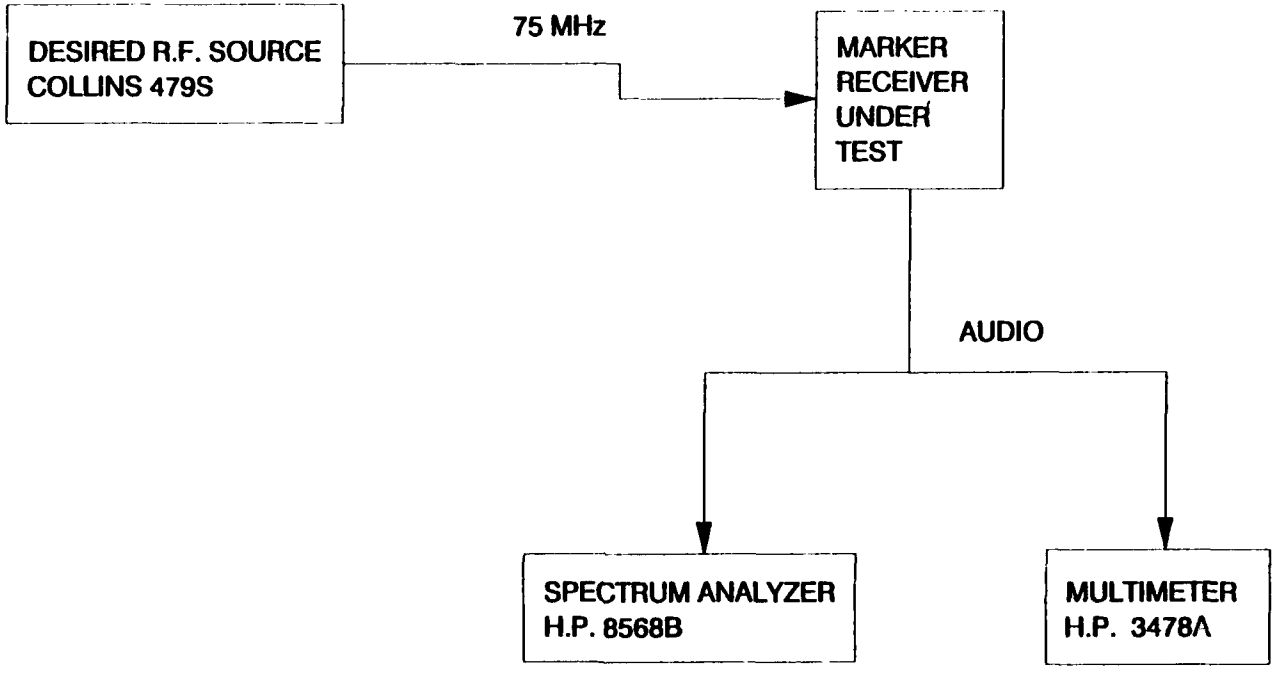

FIGURE 2. SELECTIVITY MEASUREMENT CONFIGURATION

In addition, the tone modulation was turned off at each interfering level to confirm that the effect was due to the modulation and not the carrier. These tests were performed for OM, MM, and IM configurations.

Selectivity Measurements. The selectivity measurements which were made with the desired signal set to a level below which receiver automatic gain control (AGC) action began, were performed at the 6-, 40-, and 60-dB points. This measurement was made by recording the receiver's audio output at center frequency followed by finding the frequency at which a 6-, 40-, or 60-dB increase in desired signal level produces the same audio outpuput level. Selectivity was measured in the MM mode.

TEST RESULTS AND ANALYSIS

The following analysis will be helpful in comparing these interference measurements to real-world expected interference levels:

Users of the new guard band frequencies will be constrained to 1 W maximum power. If it is assumed that an aircraft will come no closer than 200 feet to an interferer (equivalent to an aircraft in the vicinity of the MM), then the free space loss can be calculated as follows:

$$\text{Space Loss} = 37.8 + 20 \log F + 20 \log D$$

Where:

F	=	Frequency in MHz
D	=	Distance to interferer in nautical miles (nmi)
1 nmi	=	6077 feet
200 feet	=	200/6077 = 0.0329 nmi.

Then,

$$\text{Space Loss} = 37.8 + 20 \log (75) + 20 \log (0.0329)$$

$$= 45.6 \text{ dB or approximately } 46 \text{ dB.}$$

Assuming no shielding, cable, or antenna losses, an FCC Part 90, 1 W (+30 dBm) device will produce, at the aircraft receiver, a maximum signal of:

$$30 \text{ dBm} - 46 \text{ dB} = -16 \text{ dBm.}$$

On page 2 of draft FCC ET Docket No. 91-150, it states Auditory Assistance devices are permitted to operate at a maximum power of 0.0012 W (+ 0.79 dBm). At 200 feet, these radiators would produce a signal level of approximately -45 dBm, i.e., 29 dB less than Part 90 devices.

DESENSITIZATION TESTS.

The desensitization tests measured and recorded Signal-Plus-Noise (S+N) Voltage, Noise (N) Voltage, Lamp On Voltage, and Lamp Off Voltage as a function of interfering signal level. The S+N and the N voltages were used to compute the (S+N)/N ratio. The point at which the interference became audible and any abnormal visual lamp indications were also noted.

In tables 1 through 4, the (S+N)/N ratios as a function of desensitization interfering signal level are tabulated for each interfering modulation type. For example, table 1 shows that for 1300 Hz AM interference, with F1 and F2 on, receiver 4 had an (S+N)/N ratio of 35 dB at an interfering signal level of -5 dBm.

On some occasions, receiver 3 produced (S+N)/N ratios of zero or less. For these conditions, the (S+N)/N ratio was recorded as zero.

Figures 3 through 7 plot the lamp on and lamp off voltages of receivers 1 through 5, respectively for all combinations of F1 and F2. Each figure shows the effect from AM, FM, PM, and CW type interference. For example, figure 3 shows that with AM interference, receiver 1 had lamp on voltages between approximately 2.7 and 3 volts (V) and lamp off voltages of 0 V. The variation in lamp on voltages is due to differences between the Marker Receiver's internal OM, MM, and IM lamp filter circuits. For all receivers except number 5, the lamp on voltage is the more positive voltage. This is reversed for receiver 5. Receivers 1, 2, and 5 used direct current (DC) lamp voltages and receivers 3 and 4 used alternating current (AC) voltages. A tabulation of the lamp voltages shown in figures 3 through 7 is included in appendix A.

DO-143 requires Marker Receivers to have a 15 dB (absolute) (S+N)/N ratio without interference present. It states no criteria for (S+N)/N reduction due to interference from these new frequencies. If, for analysis purposes only, we allow interference to cause an additional 5-dB reduction, then a 10-dB (absolute) (S+N)/N ratio could be used as an arbitrary cutoff point. Further review of tables 1 through 4 reveals that 10-dB or less (S+N)/N ratios exist at interfering signal levels less than the -16 dBm level expected in the vicinity of the MM.

Figures 3 through 7 indicate that lamp voltages are also affected at signal levels below -16 dBm.

Amplitude Modulation. From table 1, with 1300 Hz AM interference, and both F1 and F2 on, receiver 3 experienced an (S+N)/N of 10 dB at -25 dBm (i.e., an interfering signal level 9 dB less than the -16 dBm level expected along the aircraft's approach path). It was also found that at a -16 dBm interfering level, the (S+N)/N ratio of receiver 3 could be as low as approximately 2 dB. These effects were also observed at other combinations of F1 and F2. Figure 5 shows that at -25 dBm receiver 3 lamp on/off voltages also begin to change and by -16 dBm both lamp voltages are erratic, causing the lamp to flash. Only receiver 3 degraded to a 10-dB (S+N)/N ratio and experienced erratic lamp behavior with AM interference levels at or below -16 dBm.

The (S+N)/N and lamp voltages (figure 4) of receiver 2 did not degrade with signals below -5 dBm, however at -4 dBm, in the IM mode, the lamp begins flashing. The interference was audible in both receivers 2 and 3 at interfering levels below that required to produce a 10-dB (S+N)/N ratio and was very noticeable at the 10-dB point.

TABLE 1. DESENSITIZATION EFFECT ON MARKER RECEIVERS FROM AMPLITUDE MODULATED (AM) INTERFERENCE

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Outer Marker Mode) 400 Hertz AM Interference										(S+N)/N (dB) (Middle Marker Mode) 1300 Hertz AM Interference										(S+N)/N (dB) (Inner Marker Mode) 3000 Hertz AM Interference									
	F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON				
	RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Baseline	54	38	42	40	38	54	38	42	40	38	54	38	41	40	37	54	39	41	44	46	54	39	40	42	46	54	39	41	42	46
-40	55	39	37	39	38	54	38	42	40	38	54	38	38	39	38	54	39	35	43	46	54	39	41	42	46	54	39	37	42	46
-35	54	39	26	39	38	54	38	38	40	38	54	38	29	40	38	54	39	26	43	46	54	39	37	42	46	54	39	29	42	46
-30	52	39	16	39	38	53	38	29	40	38	52	38	18	40	38	52	39	16	43	46	53	39	28	42	46	52	39	19	42	46
-25	49	39	10	40	38	46	38	19	40	38	47	38	10	39	38	49	39	10	43	46	46	39	18	42	46	47	39	11	42	46
-20	46	38	5	40	38	39	38	13	40	38	41	38	5	39	37	45	37	6	43	45	38	38	12	42	45	41	38	5	42	45
-15	44	34	2	40	36	34	37	12	40	37	36	37	1	39	36	44	32	1	43	41	33	36	12	42	45	36	36	1	42	41
-14	45	32	1	40	35	33	36	12	40	37	36	36	0	39	36	44	30	2	43	39	33	35	12	42	45	36	35	1	42	40
-13	45	31	1	40	35	32	36	11	40	37	35	35	0	39	35	44	29	0	43	38	32	34	11	42	44	35	34	2	42	39
-12	46	29	0	40	34	32	35	8	40	37	35	34	0	39	34	44	27	0	42	37	32	33	8	42	44	35	33	0	42	37
-11	45	27	1	40	31	32	33	5	40	37	34	32	1	39	32	44	24	0	41	34	31	31	6	42	43	34	30	0	42	34
-10	44	24	1	40	30	32	31	2	40	36	34	31	0	39	31	43	22	2	41	32	31	29	2	42	42	34	28	0	42	33
-9	42	22	1	39	29	32	30	1	40	36	34	29	1	39	30	42	20	1	39	31	31	27	1	42	41	34	27	1	42	31
-8	39	20	1	39	28	32	28	0	40	35	35	27	0	39	28	39	18	2	38	29	32	25	0	42	40	34	25	0	42	29
-7	36	18	1	38	27	33	26	0	40	35	35	25	0	39	27	36	15	3	37	28	32	23	0	39	39	35	23	0	42	28
-6	33	15	1	37	26	34	24	0	40	34	36	23	0	39	26	34	12	1	36	26	33	21	0	37	38	35	21	0	40	26
-5	30	12	0	37	25	37	22	0	39	33	38	21	0	40	24	31	10	2	35	25	35	19	0	36	36	36	19	0	39	24
-4	28	9	0	36	24	40	20	0	38	32	40	19	0	39	23	29	7	2	35	23	36	17	0	35	35	37	17	0	38	23
-3	26	7	0	35	23	43	17	0	37	32	45	17	0	39	22	26	6	2	34	22	38	15	0	34	34	39	14	0	37	21
-2	24	5	0	35	23	39	15	0	35	31	45	15	0	38	20	24	4	2	34	21	37	12	0	34	32	39	12	0	36	20
-1	22	4	0	34	22	34	13	0	35	30	39	12	0	37	19	22	3	2	33	21	34	10	0	34	30	37	10	0	35	18
0	20	4	0	33	22	30	10	0	35	29	35	10	0	36	18	21	3	3	33	20	30	8	0	34	29	34	7	0	35	17

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Inner Marker Mode) 3000 Hertz AM Interference									
	F1 ON F2 ON					F1 ON F2 OFF				
	RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5
Baseline	52	39	35	51	49	52	39	35	51	49
-40	53	40	33	51	49	53	39	35	51	48
-35	52	40	26	51	49	52	39	34	51	48
-30	50	39	16	51	49	51	39	28	51	48
-25	46	39	10	51	48	46	39	18	51	48
-20	42	36	5	51	45	38	38	12	51	48
-15	41	30	2	51	38	33	36	14	51	47
-14	41	28	1	51	37	32	34	12	51	46
-13	41	26	2	49	35	32	33	8	51	45
-12	41	25	2	46	33	32	32	10	51	44
-11	40	22	0	45	30	31	30	4	51	42
-10	40	20	2	44	28	31	27	4	51	40
-9	39	18	2	43	26	31	26	2	51	38
-8	37	16	1	42	25	32	24	0	51	36
-7	35	13	0	42	23	33	22	0	51	35
-6	32	11	3	41	21	34	20	0	47	33
-5	30	8	0	41	20	36	17	0	44	31
-4	27	7	0	41	18	39	15	1	43	29
-3	25	5	0	40	17	42	13	1	42	27
-2	23	3	0	40	15	40	11	0	41	25
-1	21	2	0	39	14	34	9	0	40	23
0	20	2	0	39	13	31	6	0	40	21

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Inner Marker Mode) 3000 Hertz AM Interference									
	F1 OFF F2 ON									
	RECEIVER									
	1	2	3	4	5					
Baseline	52	39	35	52	48					
-40	53	39	35	52	48					
-35	52	39	29	52	48					
-30	51	39	18	51	48					
-25	46	38	9	52	48					
-20	41	37	5	52	46					
-15	36	34	2	52	40					
-14	36	33	0	51	39					
-13	35	31	2	51	37					
-12	35	30	2	51	36					
-11	34	27	3	51	33					
-10	34	26	0	52	31					
-9	34	24	0	49	29					
-8	34	22	0	44	27					
-7	35	20	3	42	25					
-6	35	18	0	42	23					
-5	36	16	4	41	21					
-4	37	14	4	41	19					
-3	38	12	0	41	18					
-2	37	10	0	41	16					
-1	35	8	4	40	15					
0	33	6	0	40	13					

TABLE 2. DESENSITIZATION EFFECT ON MARKER RECEIVERS FROM FREQUENCY MODULATED (FM) INTERFERENCE

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Outer Marker Mode) 400 Hertz FM Interference										(S+N)/N (dB) (Middle Marker Mode) 1300 Hertz FM Interference										(S+N)/N (dB) (Inner Marker Mode) 3000 Hertz FM Interference									
	F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON				
	RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Baseline	54	38	43	40	38	54	38	44	40	37	53	38	43	40	37	53	39	41	45	46	54	39	41	45	46	54	39	41	42	46	52	39	38	50	48	52	39	38	50	48	52	39	38	50	48
-40	55	39	43	40	38	54	38	44	40	38	54	38	44	40	38	54	40	41	45	46	54	39	41	44	46	54	39	42	42	46	53	40	38	50	49	53	39	38	50	49	52	39	38	50	49
-35	55	39	38	40	38	54	38	43	40	38	54	38	43	40	38	54	39	37	45	46	54	39	40	44	46	54	39	41	42	46	53	40	36	50	49	53	39	38	50	49	53	39	38	50	49
-30	55	39	28	40	38	54	38	38	40	38	54	38	39	40	38	54	39	28	45	46	54	39	38	44	46	54	39	39	42	46	53	40	28	50	49	53	39	37	50	49	52	39	37	50	49
-25	53	39	19	40	38	53	38	30	40	38	53	38	32	40	38	53	39	19	45	46	53	39	31	44	46	54	39	33	42	46	52	39	19	50	49	52	39	30	50	49	52	39	32	50	49
-20	50	38	12	40	38	50	38	17	40	38	52	38	27	40	38	50	39	12	45	46	50	39	18	43	46	52	39	27	42	46	49	39	11	50	49	49	39	18	50	49	51	39	27	50	48
-15	45	38	6	40	37	47	38	4	40	37	50	38	23	40	37	45	39	6	45	45	47	39	5	43	46	50	39	24	42	45	44	39	6	50	48	46	39	7	50	48	50	39	22	50	48
-14	44	37	5	40	37	46	38	2	40	37	50	38	24	40	37	44	38	5	45	45	46	39	3	43	46	50	39	24	42	45	44	38	1	50	47	46	39	3	50	48	49	39	23	50	47
-13	44	37	4	40	37	46	38	1	40	37	50	38	26	40	37	44	38	4	45	44	46	39	1	43	46	50	39	25	42	44	43	38	4	50	47	45	39	4	50	48	49	39	23	50	47
-12	43	37	4	40	36	46	38	0	40	37	49	38	27	40	36	43	37	3	45	44	46	39	0	43	46	49	39	28	42	44	43	37	6	50	46	45	39	3	50	48	49	39	26	50	46
-11	43	35	3	40	35	46	38	0	40	37	49	37	17	40	36	43	36	2	45	42	46	39	0	42	45	49	38	19	42	43	42	36	5	50	44	45	39	2	50	48	48	38	21	50	44
-10	42	34	1	40	34	46	37	0	40	37	49	37	12	40	35	42	35	1	45	41	46	38	0	43	45	49	38	14	42	42	41	35	3	50	44	45	38	0	50	47	48	38	15	50	43
-9	42	33	1	40	33	46	37	0	40	36	49	37	6	40	34	41	34	1	45	40	46	38	0	43	44	49	38	10	42	40	41	34	3	50	42	45	38	0	50	47	48	38	11	50	42
-8	41	32	1	40	32	46	37	0	40	36	49	37	5	40	33	41	33	0	45	39	46	38	0	42	44	49	37	6	42	39	41	33	1	50	41	45	38	0	50	46	48	37	6	50	40
-7	41	30	0	40	31	47	37	0	40	36	49	36	0	40	32	41	31	0	45	38	46	38	0	43	44	49	37	3	42	38	41	31	2	50	40	46	38	0	50	45	48	37	4	50	39
-6	41	29	0	40	30	47	37	0	40	35	49	36	2	40	31	41	30	0	45	37	47	37	0	43	43	49	37	2	42	37	41	29	0	50	39	46	38	0	51	44	49	37	1	50	38
-5	41	27	0	40	29	48	36	0	40	34	49	36	0	40	30	41	28	0	45	36	47	37	0	43	42	49	36	1	42	36	41	28	0	50	37	46	37	0	51	43	49	37	0	49	36
-4	41	25	0	40	28	48	36	0	40	34	49	35	0	40	29	41	26	0	45	35	48	37	0	43	41	49	36	0	42	34	41	26	1	50	36	47	37	0	50	42	49	36	0	49	34
-3	41	23	0	40	27	49	36	0	40	33	50	35	1	40	28	40	24	0	45	33	48	37	0	42	40	50	36	0	42	33	41	24	0	50	35	47	37	0	51	40	49	36	0	49	33
-2	40	21	0	40	26	49	35	0	40	32	50	34	0	40	27	40	21	0	45	32	48	36	0	42	39	50	35	0	42	31	40	21	0	50	33	47	36	0	50	39	49	35	0	49	31
-1	40	18	0	40	25	49	35	0	40	31	50	34	0	40	26	40	19	0	45	31	49	36	0	42	38	50	35	0	42	30	40	19	0	50	32	47	36	0	50	38	49	35	0	49	29
0	40	16	0	40	23	49	34	0	40	30	50	33	0	40	25	40	17	0	45	29	49	35	0	42	37	49	34	0	42	28	40	17	0	50	30	47	35	0	50	36	49	34	0	49	28

TABLE 3. DESENSITIZATION EFFECT ON MARKER RECEIVERS FROM PULSE MODULATED (PM) INTERFERENCE

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Outer Marker Mode) 400 Hertz PM Interference															(S+N)/N (dB) (Middle Marker Mode) 1300 Hertz PM Interference															(S+N)/N (dB) (Inner Marker Mode) 3000 Hertz PM Interference														
	F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON				
	RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Baseline	55	38	42	38	37	55	38	43	38	38	53	38	38	38	38	54	39	43	43	44	54	39	37	43	46	52	39	38	43	44	53	39	43	51	49	52	39	38	52	49	51	39	38	50	47
-40	52	35	39	37	37	53	37	40	38	37	42	36	34	38	37	49	33	35	38	43	52	35	36	43	44	42	35	33	43	42	45	31	32	42	44	50	32	33	52	44	41	32	32	50	44
-35	48	32	32	34	36	51	34	37	36	36	42	34	31	37	36	45	29	29	35	40	49	31	32	38	43	42	31	30	35	41	41	26	26	40	40	47	28	29	41	40	39	28	28	41	43
-30	44	28	22	33	33	48	31	32	33	34	42	30	25	34	34	40	24	21	34	36	44	27	27	34	40	40	27	24	33	40	36	21	20	39	35	42	23	24	39	36	36	23	22	39	41
-25	39	23	14	32	29	44	26	25	32	31	42	26	16	32	31	36	19	13	32	32	37	22	20	33	37	37	22	15	32	37	30	16	12	37	30	38	18	18	38	32	32	18	15	38	37
-20	35	20	8	31	24	38	21	17	32	26	39	21	6	31	27	30	14	7	31	27	33	17	13	32	32	33	17	8	31	33	25	11	7	1	25	32	13	11	37	27	27	13	8	34	33
-15	29	17	6	31	19	32	18	17	30	22	34	19	3	30	22	25	10	5	5	22	28	12	12	29	28	28	12	2	30	28	19	7	4	1	20	27	9	6	1	23	22	9	3	2	28
-14	28	17	5	31	18	31	18	15	30	21	33	17	3	30	21	25	9	4	0	21	27	11	11	0	27	27	11	2	29	27	18	6	4	1	19	25	8	5	1	22	20	8	3	2	27
-13	28	16	5	31	17	30	17	12	30	20	32	17	2	30	20	25	9	4	0	20	26	10	7	0	26	26	10	2	29	26	17	6	3	1	18	25	7	4	1	21	19	7	2	2	26
-12	26	16	4	31	16	29	17	5	31	19	30	16	2	30	19	24	8	4	0	19	25	10	5	0	25	25	9	2	0	25	16	5	3	1	17	24	6	3	1	21	18	6	2	2	25
-11	25	16	4	31	16	28	16	5	31	18	29	16	1	30	18	22	7	4	0	18	24	9	5	0	24	23	9	2	0	24	14	4	3	1	16	23	5	2	1	20	17	5	2	2	24
-10	24	15	4	31	14	27	16	3	31	17	28	15	1	30	17	20	7	3	0	17	23	8	3	0	23	22	8	1	0	23	13	4	3	2	15	22	5	2	1	19	16	5	2	2	23
-9	23	11	4	32	13	26	15	2	31	16	27	15	2	31	16	19	6	4	0	16	21	7	2	0	22	21	7	0	0	22	11	3	3	2	14	21	4	1	1	18	15	4	2	3	22
-8	22	10	3	31	12	25	14	1	31	15	26	14	0	30	15	19	5	3	0	15	20	7	1	0	21	20	7	2	0	20	10	2	2	2	13	19	3	1	1	17	14	3	2	3	21
-7	22	9	4	32	11	24	11	0	32	14	25	10	2	31	14	18	5	3	0	14	19	6	1	0	20	19	6	2	0	20	9	2	2	2	12	18	3	0	1	16	12	3	2	3	20
-6	21	9	4	32	10	23	10	0	32	12	24	10	1	32	13	17	4	3	0	13	18	5	0	0	19	18	5	1	0	18	8	1	3	3	11	18	2	0	2	15	11	2	1	3	19
-5	20	8	4	32	9	21	9	0	33	11	23	9	2	32	12	16	3	3	0	12	17	5	0	0	18	16	5	1	0	17	7	1	2	3	10	17	2	0	2	15	10	2	1	3	18
-4	19	8	4	33	8	20	9	0	33	11	22	8	0	33	11	15	3	3	0	11	16	4	0	31	16	15	4	0	0	16	6	1	2	3	9	15	1	0	3	14	9	1	1	3	17
-3	19	8	4	33	7	19	8	0	33	10	21	8	1	33	10	14	3	2	0	11	15	3	0	31	15	14	3	0	0	15	5	0	2	3	8	14	1	0	3	13	7	1	1	3	15
-2	18	6	4	32	6	19	7	0	33	9	20	7	2	33	10	14	2	3	0	10	14	3	0	0	14	12	2	1	0	14	4	0	2	2	7	11	0	0	4	12	6	1	1	3	14
-1	19	6	4	33	6	18	7	0	34	8	19	7	0	33	8	13	2	3	0	9	13	2	0	0	12	11	2	1	0	13	4	0	2	2	7	9	0	0	5	11	5	0	1	3	13
0	19	5	4	33	4	17	7	0	33	7	18	7	1	33	7	13	2	3	0	8	12	2	0	0	11	11	1	1	0	12	4	0	2	1	6	9	0	0	4	11	4	0	1	3	12

TABLE 4. DESENSITIZATION EFFECT ON MARKER RECEIVERS FROM CONTINUOUS WAVE (CW) INTERFERENCE

F1/F2 Signal Level (dBm)	(S+N)/N (dB) (Outer Marker Mode) Continuous Wave Interference			(S+N)/N (dB) (Middle Marker Mode) Continuous Wave Interference			(S+N)/N (dB) (Inner Marker Mode) Continuous Wave Interference		
	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON
	RECEIVER	RECEIVER	RECEIVER	RECEIVER	RECEIVER	RECEIVER	RECEIVER	RECEIVER	RECEIVER
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Baseline	54 38 44 39 37	54 38 43 40 37	54 38 44 40 37	54 39 45 43 45	54 39 43 44 45	54 39 43 44 45	52 39 39 52 48	52 39 38 52 48	52 39 38 52 48
-40	55 39 42 39 37	55 38 44 40 37	54 38 44 40 37	55 40 42 43 46	54 39 43 44 45	54 39 43 44 45	53 40 39 52 48	53 39 38 52 48	53 39 38 52 48
-35	55 39 34 39 37	55 38 43 40 37	54 38 44 40 37	55 40 34 43 46	54 39 42 44 45	54 39 43 44 45	53 40 33 52 48	53 39 38 52 48	53 39 39 52 48
-30	55 39 24 39 37	54 38 42 40 37	54 38 44 40 37	54 39 24 43 46	54 39 41 44 45	54 39 43 44 45	53 40 23 52 48	53 39 38 52 48	53 39 39 52 48
-25	54 39 16 39 37	54 38 39 40 37	54 38 43 40 37	53 39 16 43 45	54 39 38 44 45	54 39 43 44 45	52 40 16 52 48	53 39 37 52 48	53 39 39 52 48
-20	51 39 10 39 37	54 38 35 40 37	54 38 42 40 37	50 39 10 43 45	54 39 33 44 45	54 39 42 44 45	49 39 10 52 48	53 39 33 52 48	52 39 40 52 48
-15	48 38 9 39 36	54 38 28 40 37	54 38 39 40 36	48 39 9 43 45	54 39 27 44 45	54 39 39 44 45	46 39 9 52 47	52 39 27 52 48	52 39 39 52 47
-14	48 38 9 39 36	54 38 27 40 37	54 38 38 40 36	47 38 9 43 44	54 39 26 44 45	54 39 38 44 44	46 38 9 52 47	52 39 26 52 48	52 39 38 52 47
-13	47 37 9 39 35	54 38 26 40 36	54 38 37 40 36	47 38 9 44 44	54 39 24 44 45	54 39 37 44 44	45 38 9 52 47	52 39 24 52 47	52 39 36 52 47
-12	47 37 9 39 35	54 38 24 40 37	54 38 35 40 36	46 37 9 44 44	54 39 23 44 45	54 39 36 44 44	45 38 9 52 46	52 39 23 52 47	52 39 35 52 47
-11	46 35 10 39 34	54 38 23 40 36	54 37 33 40 35	46 36 10 44 42	54 39 21 44 45	53 38 34 44 43	44 36 10 52 46	52 39 21 52 47	52 38 33 52 46
-10	46 34 10 39 33	54 38 20 40 36	54 37 32 40 34	45 35 10 44 42	54 38 19 44 44	53 38 32 44 43	44 35 10 52 45	52 39 18 52 47	52 38 32 52 46
-9	45 33 10 39 32	54 38 18 40 35	53 37 31 40 34	45 34 10 44 41	53 38 17 44 44	53 38 31 44 42	44 34 10 52 44	52 38 16 52 46	52 38 31 52 45
-8	45 32 10 39 32	54 37 17 40 35	53 37 30 40 33	45 33 10 44 40	53 38 15 44 44	53 38 30 44 42	43 33 10 52 43	52 38 14 52 46	51 38 30 52 45
-7	45 30 10 39 31	54 37 15 40 35	53 37 28 40 32	44 31 10 44 40	53 38 14 44 43	53 37 29 44 41	43 31 10 52 43	52 38 13 52 46	51 37 29 52 44
-6	44 28 10 39 30	53 37 14 40 35	53 36 27 40 32	44 29 10 44 39	53 38 13 44 43	53 37 28 44 40	43 30 10 52 42	51 38 11 52 45	51 37 28 52 43
-5	44 26 10 39 29	53 37 13 40 34	52 36 26 40 31	44 27 10 44 38	53 38 12 44 42	52 37 27 44 40	42 28 10 52 41	51 38 9 52 45	51 37 27 52 42
-4	43 24 10 39 28	53 37 12 40 33	52 36 25 40 30	43 25 10 44 38	53 37 11 44 42	52 36 26 44 39	42 26 10 52 40	51 37 7 52 44	50 36 26 52 42
-3	43 22 10 39 28	53 36 11 40 32	52 35 24 40 29	42 23 10 44 37	52 37 10 44 41	52 36 25 44 38	41 24 10 52 40	51 37 5 52 43	50 36 25 52 41
-2	42 20 9 39 27	52 36 10 40 32	51 35 23 40 29	41 21 10 44 36	52 37 9 44 41	51 35 23 44 37	40 21 9 52 39	50 37 4 52 43	50 35 24 52 40
-1	41 18 9 39 26	52 36 9 40 31	51 34 21 40 28	40 19 9 43 35	52 36 8 44 40	51 35 22 44 37	39 19 9 52 38	50 36 3 52 42	49 35 22 52 40
0	39 15 9 39 25	51 35 9 40 30	50 34 20 40 27	39 16 9 43 34	51 36 8 44 39	50 34 21 44 36	38 17 9 52 37	49 36 2 52 41	49 34 21 52 39

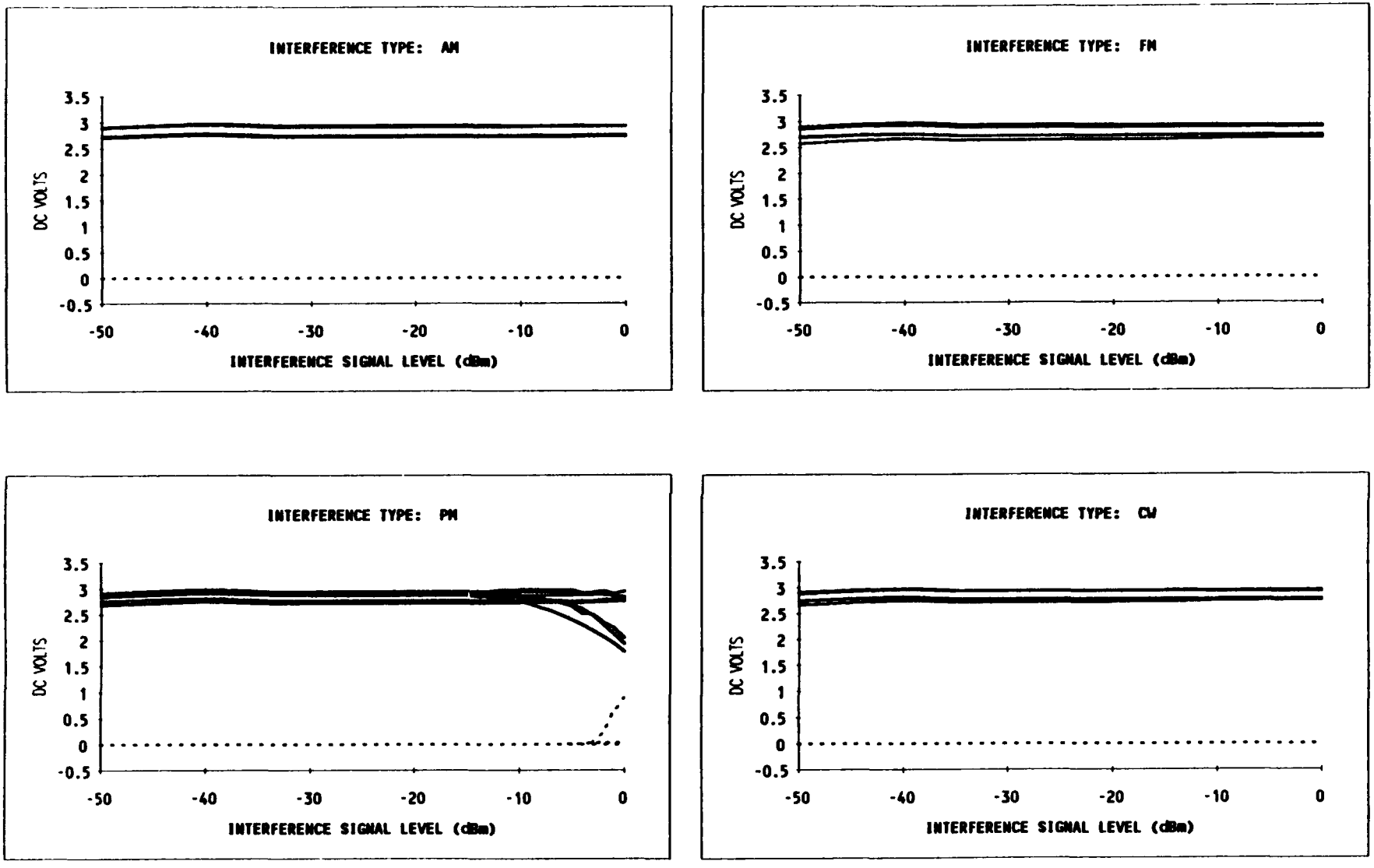

FIGURE 3. DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER ONE'S LAMP VOLTAGE

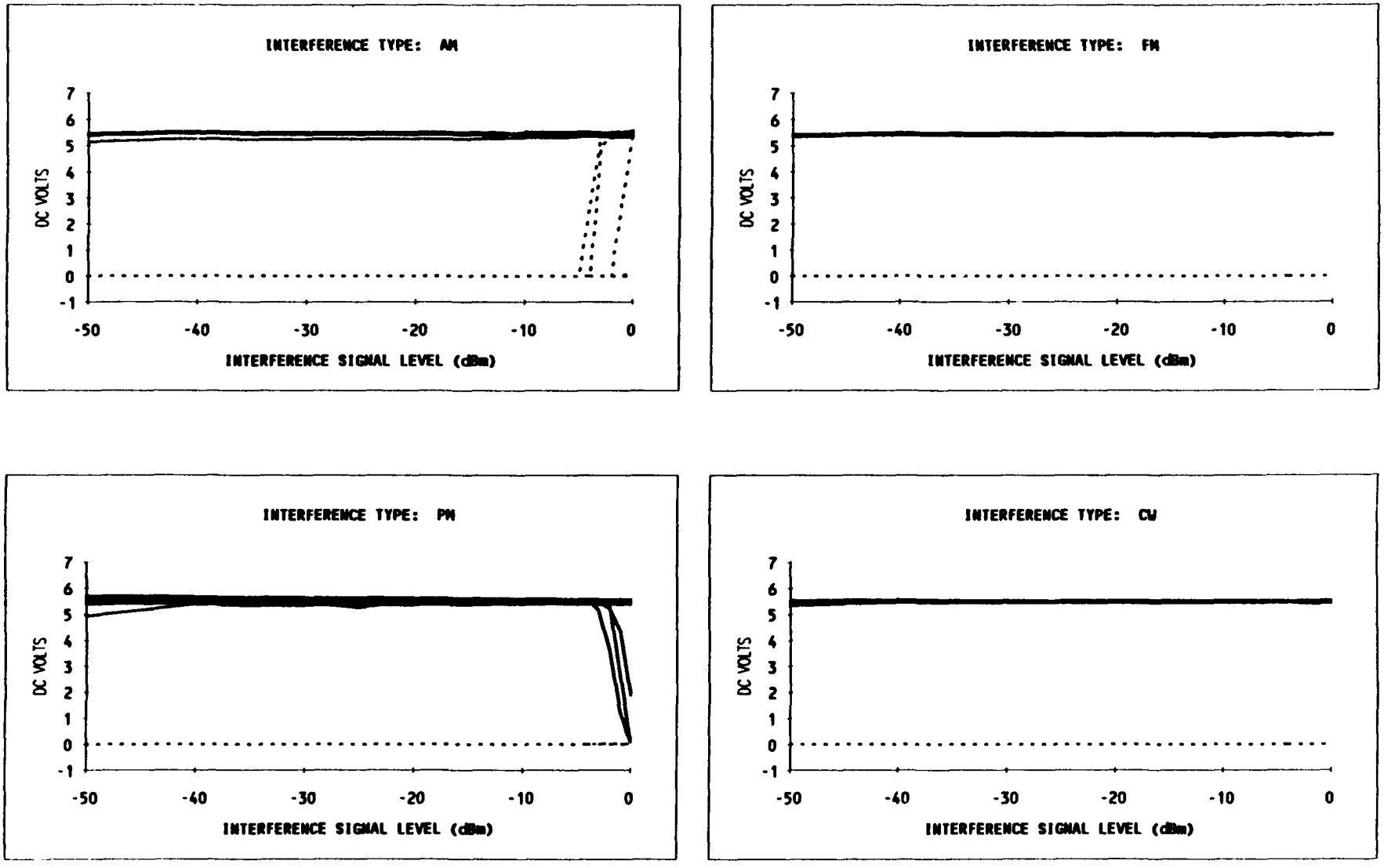

FIGURE 4. DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER TWO'S LAMP VOLTAGE

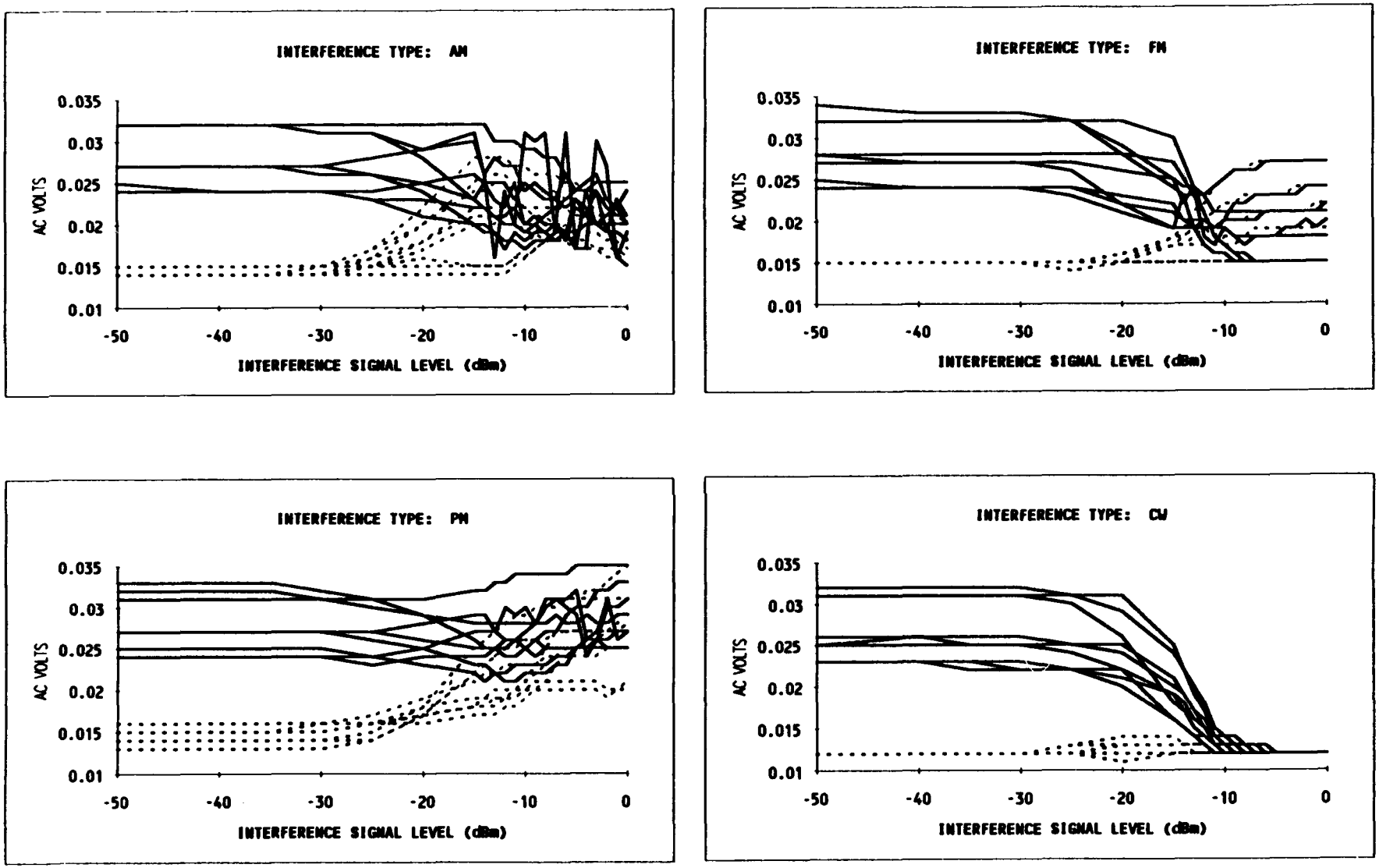

FIGURE 5. DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER THREE'S LAMP VOLTAGE

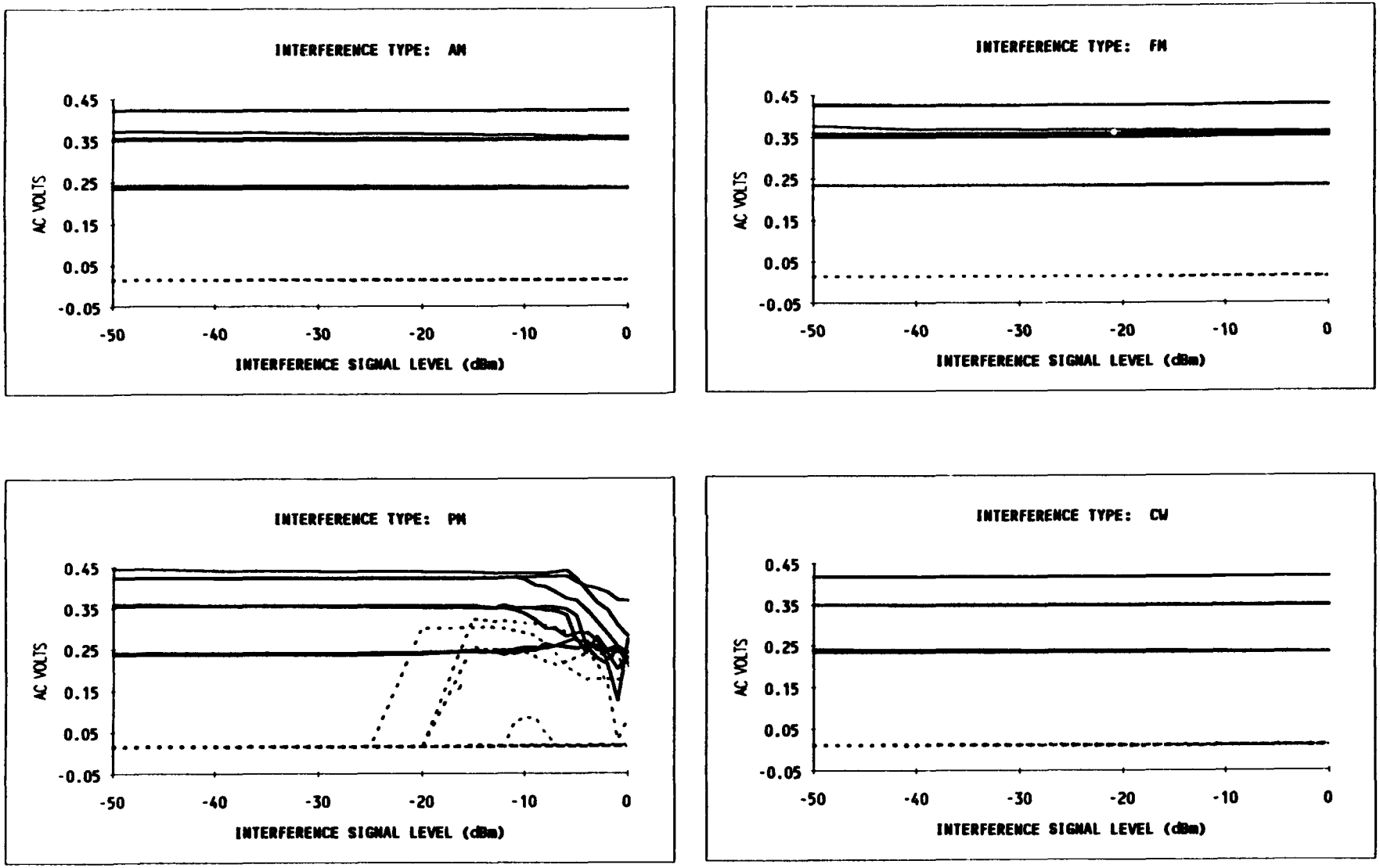

FIGURE 6. DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FOUR'S LAMP VOLTAGE

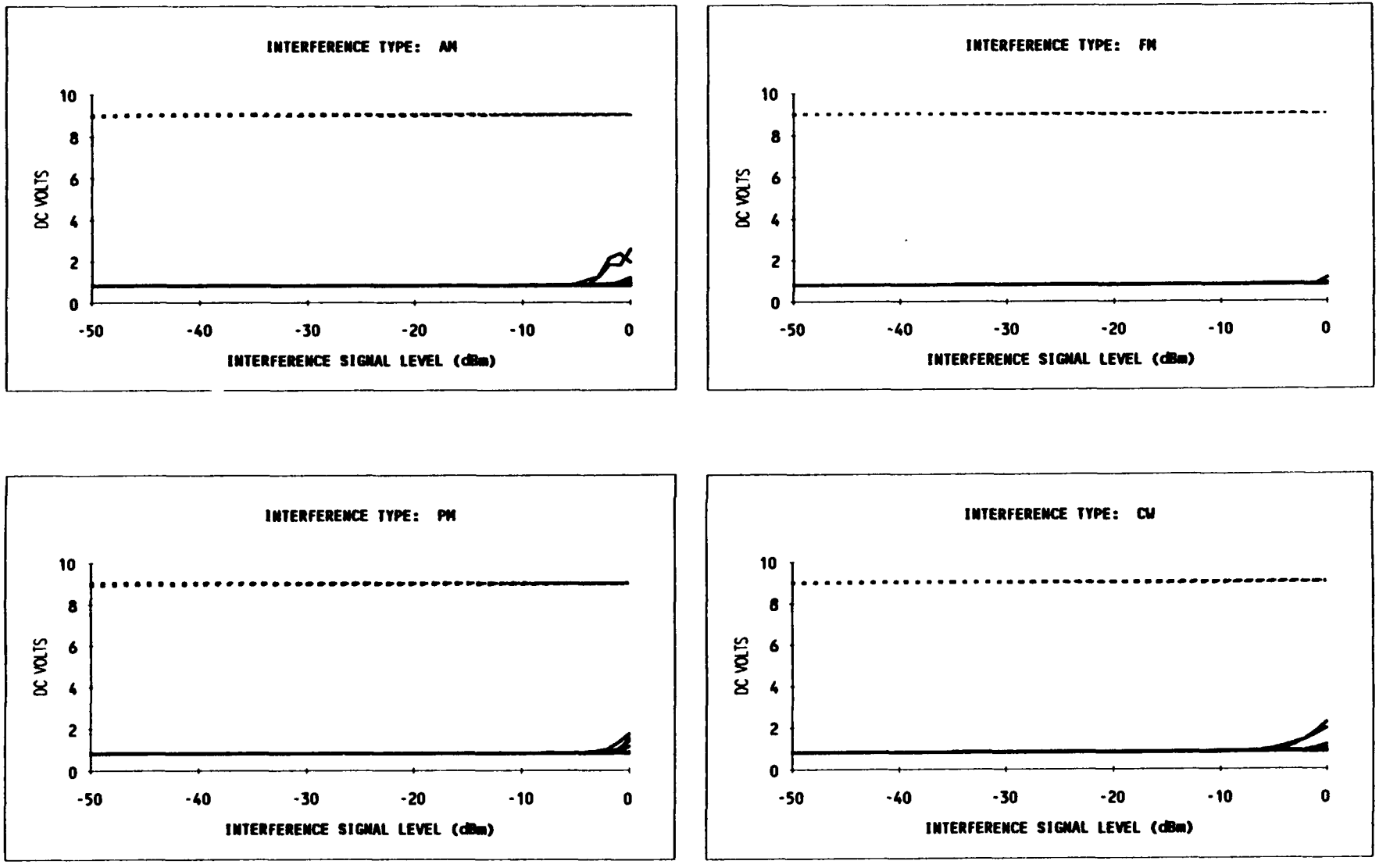

FIGURE 7. DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FIVE'S LAMP VOLTAGE

Receivers 1, 4, and 5 did not degrade to a 10-dB (S+N)/N ratio even with interference levels up to 0 dBm; however, receiver 5 (figure 7), in the IM mode, does show a small increase in lamp on voltages beginning at -5 dBm and displays a flashing light at -3 dBm. The interference was not audible on these three receivers.

> Note: Using the above space loss equation, it is calculated that a -25 dBm interfering level corresponds to an aircraft passing within 587 feet of the interferer. An aircraft making an instrument approach using a 3° glide slope angle would reach this altitude approximately 1.8 nmi from touchdown.

Frequency Modulation. With FM interference, table 2 shows that only receiver 3 experienced 10-dB or less (S+N)/N ratios. This occurred at interfering levels greater than -20 dBm. At -16 dBm, the (S+N)/N ratio would be 5 dB. The lamp voltages on figure 5 also show the effect begins at -20 dBm with a flashing light noticeable at -15 dBm in all Marker modes. The interference became audible around the 10-dB (S+N)/N point.

Receivers 1, 2, 4, and 5 did not degrade to 10 dB or produce audible interference even with interference levels up to 0 dBm, however receiver 5 exhibited a slight change in lamp on voltage at -2 dBm.

Pulse Modulation. Pulse modulation, as shown on table 3, affected all five receivers. Most susceptible were receivers 3 and 4 which decreased to 10-dB (S+N)/N at approximately -23 dBm, a slight improvement over AM interference. Figures 5 and 6 show the lamp voltages also start changing at this point. Receiver 3 experienced a flashing light condition by -15 dBm in all Marker modes. In the MM mode at -4 dBm with F1 on and F2 off, receiver 4 experienced a sudden increase in (S+N)/N from 0 to 31 dB and back to 0 dB by -2 dBm. This was due to a sudden decrease in the Noise level caused by an unknown receiver mechanism (possibly an AGC response to frequency F1, the PM PRF, and signal level combination).

Next, to degrade to a 10-dB (S+N)/N ratio, was receiver 2 at -17 dBm, although the lamp voltages (figure 4) remained unaffected until -2 dBm. Least susceptible were receivers 1 and 5 at -8 and -6 dBm, respectively with only minimal change in lamp voltages.

At -16 dBm, receivers 2, 3, and 4 had (S+N)/N ratios of 8, 5, and 7 dB, respectively.

With PM, the interference often became audible at signal levels below that required to produce a 10-dB (S+N)/N ratio.

Continuous Wave. With CW interference, table 4 indicates that only receiver 3 degraded to a 10-dB (S+N)/N ratio. This occurred at a -20 dBm interfering level which is also the point at which figure 5 shows the lamp on voltage decreasing. There was little change in (S+N)/N between this point and -16 dBm but lamp on voltages continued to decrease causing the lamp to turn off.

Receivers 1, 2, 4, and 5 did not reach 10 dB even with CW interference levels up to 0 dBm and receiver 5's lamp voltage was only minimally affected. No audible interference was observed on any receiver with CW interference.

NO-DESIRED SIGNAL.

The no-desired signal test recorded the interfering signal levels at which the interfering tone becomes audible and the lamp(s) turns on. Due to the lamp filter circuits in the receivers, the tone becomes audible at signal levels below that required to turn on the lamp. This information is presented in tables 5 through 7. In these tables, the letter T indicates the interfering tone is audible. The letter B indicates that both the interfering tone is audible and the lamp corresponding to the interfering tone frequency is on.

The letter U indicates the interfering tone is audible and an unselected lamp is lit. (An unselected lamp is when the receiver is being tested with interference using the OM tone, for example, and the MM lamp turns on.) The letter M means the interfering tone is audible and multiple lamps are lit.

Amplitude Modulation. With AM interference, table 5 shows that with no-desired signal present, receivers 3 and 5 produce an audible tone at interfering signal levels below -16 dBm. Receiver 3 also experienced lamp on conditions with interfering levels as low as -13 dBm. For example, in the MM mode with F1 on and F2 off, receiver 3 produced an audible tone at -25 dBm and turned on the MM lamp at -13 dBm.

Receiver 2 produced a tone by -15 dBm. Receiver 1 was minimally affected and receiver 4 was not affected by this type interference. Receivers 1, 2, 4, and 5 did not produce any lamp on conditions with signals up to 0 dBm.

Frequency Modulation. Table 6 shows the effect no-desired signal, FM interference has on the receivers. Receiver 3 produces an audible tone at interfering levels as low as -35 dBm and lamp on indications at -15 dBm. Receiver 3 experienced this level of interference for several test conditions.

Receiver 5 produced an audible output at -11 dBm but did not turn on the lamp with levels up to 0 dBm. Receivers 1, 2, and 4 produced no audible tone or lamp on condition.

Pulse Modulation. No-desired signal, PM interference as shown on table 7 affected all five receivers with receivers 2 and 3 most affected. With 400 Hz interference and F1 and F2 on, receiver 2 produced a tone at -35 dBm. At -14 dBm an unselected lamp turned on also. By -9 dBm, the tone was on and multiple lamps were lit. Only receiver 2 produced this multiple lamp condition. Receiver 3 produced audible tone at -35 dBm and both tone and lamp on by -15 dBm.

Receiver 1 produced tone by -25 dBm and unselected lamp on by -10 dBm. Receiver 4 and 5 produced tone by -8 and -20 dBm, respectively but did not turn on the lamp.

Continuous Wave. The no-desired signal tests were not performed with CW type interference because the desensitization tests had shown that CW does not cause a tone and it turns the lamp off but not on. Therefore, without a desired signal, there were no parameters to observe.

> Note: Using the space loss equation, it is found that the above -35 dBm interfering level occurs at a distance of 1856 feet from a 1-W transmitter. An aircraft on a 3° glide slope angle would reach this altitude 5.8 nmi from touchdown which is in the vicinity of the OM.

TABLE 5. EFFECT ON MARKER RECEIVERS FROM AMPLITUDE MODULATED (AM) INTERFERENCE WITH NO-DESIRED SIGNAL

F1/F2 Signal Level (dBm)	INTERFERENCE POINT (Outer Marker Mode) 400 Hertz AM Interference									INTERFERENCE POINT (Middle Marker Mode) 1300 Hertz AM Interference									INTERFERENCE POINT (Inner Marker Mode) 3000 Hertz AM Interference								
	F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON				
	RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-40																														
-35																														
-30		T					T															T					T			
-25		T					T					T					T					T					T			
-20		T					T					T					T					T					T			
-15		T					T				T		T				T				T	T				T	T			
-14		T					T				T		T			T	T				T	T				T	T			
-13		T					B				T		T			T	T				B	T				T	T			
-12		T					B				T		T			T	T	T			T	B	T			T	T			
-11		T					B				T		T			T	T	T			T	B	T			T	T	T		
-10		T					B				T		T			T	T	T			T	B	T			T	T	T		
-9		T					B				T		T			T	T	T			T	B	T			T	T	T		
-8		T				T	B				T	T				T	T	T			T	B	T			T	T	T		
-7	T	T				T	B				T	T				T	T	T			T	B	T			T	T	T		
-6	T	T				T	B				T	T'				T	T	T			T	B	T			T	T	T		
-5	T	T	T			T	B				T	T	T			T	T	T			T	B	T			T	T	T		
-4	T	T	T			T	B				T	T	T			T	T	T			T	B	T			T	T	T		
-3	T	T	T			T	B				T	T	T			T	T	T			T	B	T			B	T	T		
-2	T	T	T			T	B			T	T	T	T			T	T	T			T	B	T			B	T	T		
-1	T	T	T			T	B			T	T	T	T			T	T	T			T	B	T			T	B	T		
0	T	T	T			T	B			T	T	T	T			T	T	T			T	B	T			T	B	T		

T indicates that the interference (tone) is audible.

B indicates that the lamp lites and the tone is audible.

TABLE 6. EFFECT ON MARKER RECEIVERS FROM FREQUENCY MODULATED (FM) INTERFERENCE WITH NO-DESIRED SIGNAL

F1/F2 Signal Level (dBm)	INTERFERENCE POINT (Outer Marker Mode) 400 Hertz FM Interference			INTERFERENCE POINT (Middle Marker Mode) 1300 Hertz FM Interference			INTERFERENCE POINT (Inner Marker Mode) 3000 Hertz FM Interference		
	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON	F1 ON F2 ON	F1 ON F2 OFF	F1 OFF F2 ON
	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5	RECEIVER 1 2 3 4 5
-40									
-35		T		T	T		T	T	
-30	T	T					T	T	
-25	T	T		T	T		T	T	
-20	T	T		T	T	T	T	T	T
-15	T	B	T	B	B	T	T	B	T
-14	T	B	T	B	B	T	T	B	T
-13	T	B	T	B	B	T	T	B	T
-12	T	B	T	B	B	T	T	B	T
-11	T	B	T	B	B	T	T T	B	T
-10	B	B	T	B	B	T	T T	B	T
-9	B	B	T	B	B	T	B T	B	T
-8	B	B	T	B	B	T	B T	B	T T
-7	B	B	T	B	B	T	B T	B	T T
-6	B	B	T	B	B	T	B T	B	T T
-5	B	B	T	B	B	T	B T	B T	T T
-4	B	B	T	B	B	T	B T	B T	T T
-3	B	B	T	B	B	T	B T	B T	T T
-2	B	B	T	B	B	T T	B T	B T	T T
-1	B	B	T	B	B	T T	B T	B T	T T
0	B	B	T	B	B	T T	B T	B T	T T

T indicates that the interference (tone) is audible.

B indicates that the lamp lites and the tone is audible.

TABLE 7. EFFECT ON MARKER RECEIVERS FROM PULSE MODULATED (PM) INTERFERENCE WITH NO-DESIRED SIGNAL

F1/F2 Signal Level (dBm)	INTERFERENCE POINT (Outer Marker Mode) 400 Hertz PM Interference										INTERFERENCE POINT (Middle Marker Mode) 1300 Hertz PM Interference										INTERFERENCE POINT (Inner Marker Mode) 3000 Hertz PM Interference									
	F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON					F1 ON F2 ON					F1 ON F2 OFF					F1 OFF F2 ON				
	RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER					RECEIVER				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-40																														
-35	T					T					T					T	T				T	T								
-30	T	T				T	T				T	T				T	T				T	T				T	T			
-25	T	T				T	T	T			T	T				T	T	T			T	T				T	T			
-20	T	T	T		T	T	T	T			T	T				T	T	T		T	T	T	T			T	T	T		T
-15	T	T	T		T	T	T	B		T	T	T				T	U	T		T	T	T	T		T	T	T	T		T
-14	T	U	T		T	T	T	B		T	T	T				T	U	T		T	T	T	T		T	T	T	T		T
-13	T	U	T		T	T	T	B		T	T	T				T	U	T		T	T	T	T		T	T	T	T		T
-12	T	U	T		T	T	U	B		T	T	U	T			T	U	T		T	T	T	T		T	T	T	T		T
-11	T	U	T		T	T	U	B		T	T	U	T			T	U	T		T	T	T	T		T	T	T	B		T
-10	T	U	T		T	T	U	B		T	T	U	T			T	U	T		T	U	U	B		T	T	T	B		T
-9	T	M	T		T	T	U	B		T	T	U	T			T	U	T		T	U	U	B		T	T	T	B		T
-8	T	M	T		T	T	U	B		T	T	U	T			T	U	T		T	U	U	B		T	T	B	T	T	T
-7	T	M	T		T	T	U	B		T	T	U	T			T	U	T		T	U	U	B		T	T	B	T	T	T
-6	T	M	T		T	T	U	B		T	T	M	T			T	U	T		T	U	U	B		T	T	B	T	T	T
-5	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T
-4	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T
-3	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T
-2	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T
-1	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T
0	T	M	B		T	T	M	B		T	T	M	T			T	M	T		T	U	U	B		T	T	B	T	T	T

T indicates that the interference (tone) is audible.

B indicates that the lamp lites and the tone is audible.

U indicates that the tone is audible and an unselected lamp is lit.

M indicates that the tone is audible and multiple lamps are lit.

SELECTIVITY MEASUREMENT

Table 8 charts the selectivity of the five receivers in the MM mode at the 6-, 40-, and 60-dB points. The Total Bandwidth of the receiver is given for each of the above points as well as the frequency spread above and below the center (75 MHz) frequency.

Receivers 1, 2, and 4 did not exceed the new +/- 200 kHz guard band even at the 60-dB point. For example, at the 60-dB point, the receiver 4 band extended 79 kHz below center frequency and 78 kHz above for a total band of 157 kHz. Receivers 3 and 5 have 60-dB bandwidths that exceeds the new guard band and receiver 3 also exceeds -200 kHz at 40 dB. This may explain receivers 3 and 5's greater susceptibility to no-desired signal AM and FM interference but it does not entirely explain Marker receiver susceptibility to interference as evidenced by receivers 1 and 2's response to PM.

MARKER RECEIVER EQUIPMENT

Five general aviation Marker Receivers were used for this project. They are listed below in random order which does not necessarily correspond to receivers 1 through 5 referenced throughout the report.

A. NARCO CP-136
B. ARC R-402A
C. KING KR-21
D. COLLINS MKR-350
E. TERRA TM-23

TABLE 8. MARKER RECEIVER SELECTIVITY IN MIDDLE MARKER MODE

RECEIVER NUMBER	6 dB BANDWIDTH (kHz)			40 dB BANDWIDTH (kHz)			60 dB BANDWIDTH (kHz)		
	TOTAL BAND	LOWER BAND	UPPER BAND	TOTAL BAND	LOWER BAND	UPPER BAND	TOTAL BAND	LOWER BAND	UPPER BAND
1	13.5	- 6	+ 7.5	21	- 10	+ 11	62	- 31	+ 31
2	39	- 20	+ 19	79	- 38	+ 41	131	- 59	+ 72
3	95	- 76	+ 19	402	- 220	+ 182	430	- 235	+ 195
4	31.5	- 16	+ 15.5	105	- 53	+ 52	157	- 79	+ 78
5	13.5	- 7.5	+ 6	169	- 76	+ 93	764	- 340	+ 424

CONCLUSIONS

1. Equipment that generates Auditory Assistance Device signal levels (0.0012 watts (W) maximum) did not cause desensitization or no-desired signal type interference to the five Marker Receivers tested.

2. Equipment that generates Federal Communications Commission (FCC) Part 90 signal levels (1 W maximum) in these new bands can degrade Marker Receiver performance.

3. One of the five Marker Receivers tested, experienced significant ((S+N)/N ratio of 10 dB or less) desensitization when exposed to amplitude modulation, frequency modulation, pulse modulation, or continuous wave type interference at levels below what a Part 90 device is expected to produce on the instrument landing system approach path. Two other Marker Receivers also experienced significant desensitization due to pulse modulation at levels below the Part 90 limit.

4. With amplitude modulation, frequency modulation, and continuous wave type interference, the other four Marker Receivers did not experience significant desensitization until the interfering levels greatly exceeded that expected along the aircraft's approach path from a Part 90 device.

5. With no-desired signal present, amplitude modulation, frequency modulation, and pulse modulation at Part 90 device signal levels can cause a false Marker to appear. Audible and visual indications were observed on the Marker Receivers.

6. Two of these five Marker receivers had 60-dB bandwidths that exceeded the new guard band. One of these two also had a 40-dB bandwidth that exceeded the new guard band.

RECOMMENDATIONS

To reduce the affect on Marker Receivers from users of these new frequencies, it is recommended that the following requirements be incorporated into the FCC Notice of Proposed Rule Making, PR Docket No. 91-295 for Part 90 devices:

1. Transmit antennas for this new equipment shall be located at least 2000 feet from any instrument approach path.

2. Users of these new frequencies shall utilize vertically polarized antenna systems. This will provide maximum cross polarization isolation from the horizontally polarized Marker antennas.

3. Frequency Modulated (FM) or Continuous Wave (CW) type transmissions shall be utilized whenever possible. FM and CW had the least effect on the Marker Receivers tested.

4. Pulse Modulation (PM) shall be avoided whenever possible. PM affected all the Marker receivers tested.

5. The equipment shall transmit the minimum power required to perform its function and shall not exceed 1 watt (W).

APPENDIX A

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER ONE'S LAMP VOLTAGE (INTERFERENCE: F1 AND F2)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	2.70	.000	2.57	.000	2.67	.000	2.65	.000	2.89	.000	2.86	.000	2.85	.000	2.90	.000	2.90	.000	2.90	.000	2.90	.000	2.88	.000
-40	2.76	.000	2.67	.000	2.74	.000	2.75	.000	2.95	.000	2.92	.000	2.91	.000	2.97	.000	2.98	.000	2.98	.000	2.93	.000	2.96	.000
-35	2.72	.000	2.63	.000	2.70	.000	2.71	.000	2.91	.000	2.88	.000	2.87	.000	2.93	.000	2.95	.000	2.94	.000	2.90	.000	2.92	.000
-30	2.71	.000	2.63	.000	2.70	.000	2.71	.000	2.91	.000	2.88	.000	2.86	.000	2.92	.000	2.94	.000	2.93	.000	2.90	.000	2.92	.000
-25	2.71	.000	2.64	.000	2.70	.000	2.71	.000	2.91	.000	2.88	.000	2.86	.000	2.92	.000	2.94	.000	2.93	.000	2.90	.000	2.92	.000
-20	2.71	.000	2.64	.000	2.71	.000	2.71	.000	2.91	.000	2.88	.000	2.87	.000	2.92	.000	2.94	.000	2.93	.000	2.89	.000	2.92	.000
-15	2.72	.000	2.64	.000	2.71	.000	2.72	.000	2.91	.000	2.88	.000	2.87	.000	2.92	.000	2.94	.000	2.93	.000	2.85	.000	2.92	.000
-14	2.72	.000	2.65	.001	2.71	.000	2.72	.000	2.91	.000	2.88	.000	2.87	.000	2.92	.000	2.94	.000	2.93	.000	2.84	.000	2.92	.000
-13	2.72	.000	2.65	.001	2.71	.000	2.72	.000	2.91	.000	2.88	.000	2.87	.000	2.92	.000	2.94	.000	2.93	.000	2.83	.000	2.92	.000
-12	2.72	.000	2.65	.001	2.71	.000	2.73	.000	2.91	.000	2.88	.000	2.87	.000	2.92	.000	2.94	.000	2.93	.000	2.81	.000	2.92	.000
-11	2.72	.000	2.65	.000	2.71	.000	2.73	.000	2.91	.000	2.88	.000	2.86	.000	2.92	.000	2.93	.000	2.92	.000	2.78	.000	2.92	.000
-10	2.72	.000	2.65	.001	2.71	.000	2.73	.000	2.91	.000	2.88	.000	2.86	.000	2.92	.000	2.93	.000	2.92	.000	2.74	.000	2.92	.000
-9	2.72	.000	2.66	.001	2.71	.000	2.73	.000	2.91	.000	2.88	.000	2.85	.000	2.93	.000	2.93	.000	2.92	.000	2.69	.000	2.92	.000
-8	2.72	.000	2.66	.001	2.72	.000	2.74	.000	2.91	.000	2.88	.000	2.86	.000	2.93	.000	2.93	.000	2.92	.000	2.62	.000	2.92	.000
-7	2.72	.000	2.66	.000	2.72	.000	2.74	.000	2.91	.000	2.88	.000	2.86	.000	2.93	.000	2.93	.000	2.92	.000	2.56	.000	2.92	.000
-6	2.72	.000	2.66	.001	2.72	.000	2.74	.000	2.91	.000	2.88	.000	2.86	.000	2.93	.000	2.93	.000	2.92	.000	2.47	.002	2.92	.000
-5	2.72	.000	2.67	.001	2.73	.000	2.74	.000	2.91	.000	2.88	.000	2.87	.000	2.93	.000	2.93	.000	2.91	.000	2.39	.006	2.92	.000
-4	2.72	.000	2.67	.001	2.74	.000	2.74	.000	2.91	.000	2.88	.000	2.87	.000	2.93	.000	2.93	.000	2.91	.000	2.29	.013	2.92	.000
-3	2.72	.000	2.67	.001	2.74	.000	2.74	.000	2.91	.000	2.88	.000	2.88	.000	2.93	.000	2.92	.000	2.91	.00C	2.18	.020	2.92	.000
-2	2.72	.000	2.67	.001	2.75	.000	2.74	.000	2.91	.000	2.88	.000	2.88	.000	2.93	.000	2.92	.000	2.91	.000	2.05	.027	2.92	.000
-1	2.72	.000	2.67	.001	2.74	.000	2.75	.000	2.91	.000	2.88	.000	2.84	.000	2.93	.000	2.92	.000	2.91	.000	1.93	.026	2.92	.000
0	2.72	.000	2.67	.001	2.76	.000	2.75	.000	2.91	.000	2.88	.000	2.82	.000	2.93	.000	2.92	.000	2.90	.000	1.77	.028	2.91	.000

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER ONE'S LAMP VOLTAGE (INTERFERENCE: F1 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 ON AND F2 OFF							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	2.71	.000	2.69	.001	2.69	.000	2.74	.000	2.90	.000	2.85	.000	2.89	.000	2.91	.000	2.91	.000	2.89	.000	2.85	.000	2.91	.000		
-40	2.78	.000	2.76	.001	2.74	.000	2.81	.000	2.97	.000	2.96	.000	2.93	.000	2.98	.000	2.98	.000	2.96	.000	2.92	.000	2.97	.000		
-35	2.74	.000	2.72	.001	2.71	.000	2.76	.000	2.92	.000	2.91	.000	2.90	.000	2.93	.000	2.95	.000	2.92	.000	2.89	.000	2.94	.000		
-30	2.74	.000	2.71	.001	2.71	.000	2.76	.000	2.92	.000	2.91	.000	2.90	.000	2.93	.000	2.94	.000	2.92	.000	2.89	.000	2.93	.000		
-25	2.74	.000	2.71	.001	2.71	.000	2.76	.000	2.92	.000	2.91	.000	2.89	.000	2.93	.000	2.94	.000	2.92	.000	2.89	.000	2.93	.000		
-20	2.73	.000	2.71	.001	2.71	.000	2.76	.000	2.91	.000	2.91	.000	2.90	.000	2.93	.000	2.94	.000	2.92	.000	2.89	.000	2.93	.000		
-15	2.74	.000	2.71	.001	2.71	.000	2.76	.000	2.91	.000	2.91	.000	2.90	.000	2.93	.000	2.94	.000	2.91	.000	2.88	.000	2.93	.000		
-14	2.73	.000	2.71	.001	2.71	.000	2.76	.000	2.91	.000	2.91	.000	2.90	.000	2.93	.000	2.94	.000	2.91	.000	2.87	.000	2.93	.000		
-13	2.74	.000	2.72	.001	2.71	.000	2.76	.000	2.91	.000	2.91	.000	2.91	.000	2.93	.000	2.94	.000	2.91	.000	2.87	.000	2.93	.000		
-12	2.74	.000	2.72	.001	2.72	.000	2.76	.000	2.91	.000	2.91	.000	2.91	.000	2.93	.000	2.94	.000	2.91	.000	2.86	.000	2.93	.000		
-11	2.74	.000	2.72	.001	2.72	.000	2.77	.000	2.91	.000	2.91	.000	2.92	.000	2.93	.000	2.94	.000	2.91	.000	2.85	.000	2.93	.000		
-10	2.74	.000	2.71	.001	2.72	.000	2.77	.000	2.91	.000	2.91	.000	2.92	.000	2.93	.000	2.93	.000	2.91	.000	2.84	.000	2.93	.000		
-9	2.74	.000	2.71	.001	2.72	.000	2.76	.000	2.91	.000	2.91	.000	2.92	.000	2.92	.000	2.93	.000	2.91	.000	2.82	.000	2.93	.000		
-8	2.74	.000	2.72	.001	2.72	.000	2.77	.000	2.91	.000	2.91	.000	2.92	.000	2.92	.000	2.93	.000	2.91	.000	2.80	.000	2.93	.000		
-7	2.74	.000	2.72	.001	2.72	.000	2.77	.000	2.91	.000	2.90	.000	2.92	.000	2.92	.000	2.93	.000	2.91	.000	2.77	.000	2.93	.000		
-6	2.74	.000	2.72	.001	2.71	.000	2.76	.000	2.91	.000	2.90	.000	2.91	.000	2.92	.000	2.93	.000	2.91	.000	2.73	.000	2.93	.000		
-5	2.74	.000	2.72	.001	2.71	.000	2.77	.000	2.91	.000	2.90	.000	2.90	.000	2.92	.000	2.93	.000	2.91	.000	2.68	.000	2.93	.000		
-4	2.74	.000	2.71	.001	2.72	.000	2.77	.000	2.91	.000	2.90	.000	2.89	.000	2.92	.000	2.93	.000	2.91	.000	2.60	.000	2.93	.000		
-3	2.74	.000	2.72	.001	2.72	.000	2.76	.000	2.91	.000	2.90	.000	2.89	.000	2.92	.000	2.93	.000	2.91	.000	2.47	.000	2.93	.000		
-2	2.74	.000	2.72	.001	2.73	.000	2.76	.000	2.91	.000	2.90	.000	2.87	.000	2.92	.000	2.93	.000	2.91	.000	2.29	.000	2.93	.000		
-1	2.74	.000	2.72	.001	2.74	.000	2.77	.000	2.91	.000	2.90	.000	2.86	.000	2.92	.000	2.93	.000	2.91	.000	2.11	.000	2.93	.000		
0	2.74	.000	2.72	.001	2.76	.000	2.77	.000	2.91	.000	2.90	.000	2.83	.000	2.92	.000	2.93	.000	2.91	.000	1.92	.000	2.93	.000		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER ONE'S LAMP VOLTAGE (INTERFERENCE: F2 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 OFF AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	2.72	.000	2.70	.001	2.76	.000	2.75	.000	2.89	.000	2.89	.000	2.92	.000	2.91	.000	2.91	.000	2.88	.000	2.83	.000	2.91	.000		
-40	2.80	.000	2.77	.001	2.81	.000	2.82	.000	2.96	.000	2.96	.000	2.99	.000	2.97	.000	2.98	.000	2.97	.000	2.90	.000	2.98	.000		
-35	2.75	.000	2.72	.001	2.77	.000	2.77	.000	2.92	.000	2.92	.000	2.95	.000	2.93	.000	2.94	.000	2.93	.000	2.87	.000	2.94	.000		
-30	2.75	.000	2.72	.001	2.76	.000	2.77	.000	2.91	.000	2.91	.000	2.95	.000	2.92	.000	2.94	.000	2.92	.000	2.87	.000	2.94	.000		
-25	2.75	.000	2.72	.001	2.76	.000	2.77	.000	2.91	.000	2.91	.000	2.94	.000	2.92	.000	2.94	.000	2.92	.000	2.87	.000	2.94	.000		
-20	2.75	.000	2.72	.001	2.76	.000	2.77	.000	2.91	.000	2.91	.000	2.94	.000	2.92	.000	2.94	.000	2.92	.000	2.87	.000	2.94	.000		
-15	2.75	.000	2.72	.001	2.76	.000	2.77	.000	2.91	.000	2.91	.001	2.95	.000	2.92	.000	2.94	.000	2.92	.000	2.85	.000	2.94	.000		
-14	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.91	.000	2.91	.001	2.95	.000	2.92	.000	2.94	.000	2.92	.000	2.85	.000	2.94	.000		
-13	2.75	.000	2.72	.000	2.77	.000	2.77	.000	2.92	.000	2.91	.001	2.94	.000	2.92	.000	2.94	.000	2.92	.000	2.85	.000	2.94	.000		
-12	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.000	2.91	.001	2.97	.000	2.92	.000	2.94	.000	2.92	.000	2.84	.000	2.94	.000		
-11	2.75	.000	2.72	.000	2.77	.000	2.77	.000	2.92	.000	2.91	.001	2.97	.000	2.92	.000	2.94	.000	2.91	.000	2.83	.000	2.94	.000		
-10	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.000	2.91	.001	2.98	.000	2.92	.000	2.94	.000	2.91	.000	2.82	.000	2.94	.000		
-9	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.001	2.99	.000	2.92	.000	2.94	.000	2.91	.000	2.80	.000	2.94	.000		
-8	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.000	2.91	.001	2.97	.000	2.92	.000	2.94	.000	2.91	.000	2.77	.000	2.94	.000		
-7	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.000	2.97	.000	2.92	.000	2.94	.000	2.91	.000	2.74	.000	2.94	.000		
-6	2.75	.000	2.73	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.001	2.97	.000	2.92	.000	2.94	.000	2.91	.000	2.70	.000	2.94	.000		
-5	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.001	2.97	.000	2.92	.000	2.94	.000	2.91	.000	2.64	.000	2.94	.000		
-4	2.75	.000	2.72	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.001	2.92	.000	2.92	.000	2.94	.000	2.91	.000	2.51	.001	2.94	.000		
-3	2.75	.000	2.73	.000	2.75	.000	2.77	.000	2.92	.001	2.91	.001	2.93	.000	2.92	.000	2.94	.000	2.91	.000	2.49	.037	2.94	.000		
-2	2.75	.000	2.73	.000	2.78	.000	2.77	.000	2.92	.001	2.91	.001	2.95	.000	2.92	.000	2.94	.000	2.91	.000	2.33	.224	2.94	.000		
-1	2.75	.000	2.73	.000	2.78	.000	2.77	.000	2.92	.001	2.91	.001	2.90	.000	2.92	.000	2.94	.000	2.91	.000	2.24	.630	2.94	.000		
0	2.75	.000	2.73	.000	2.76	.000	2.77	.000	2.92	.001	2.91	.001	2.94	.000	2.92	.000	2.94	.000	2.91	.000	2.03	.874	2.94	.000		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER TWO'S LAMP VOLTAGE (INTERFERENCE: F1 AND F2)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	5.45	.001	5.33	.001	5.49	.001	5.38	.001	5.44	.001	5.41	.001	5.71	.001	5.36	.000	5.38	.000	5.39	.000	5.61	.000	5.48	.000
-40	5.54	.001	5.41	.001	5.55	.001	5.48	.001	5.47	.001	5.51	.001	5.68	.001	5.46	.000	5.46	.000	5.43	.000	5.57	.000	5.45	.000
-35	5.51	.001	5.38	.001	5.53	.001	5.50	.001	5.47	.001	5.49	.001	5.66	.001	5.43	.000	5.43	.000	5.41	.000	5.56	.000	5.50	.000
-30	5.51	.001	5.39	.001	5.51	.001	5.50	.001	5.47	.001	5.48	.001	5.65	.001	5.43	.000	5.42	.000	5.41	.000	5.56	.000	5.49	.000
-25	5.51	.001	5.39	.001	5.51	.001	5.44	.001	5.46	.001	5.48	.001	5.64	.001	5.42	.000	5.42	.000	5.41	.000	5.56	.000	5.48	.000
-20	5.51	.001	5.39	.001	5.53	.001	5.51	.001	5.46	.001	5.47	.001	5.63	.001	5.42	.000	5.42	.000	5.42	.000	5.57	.000	5.48	.000
-15	5.52	.001	5.38	.001	5.47	.001	5.51	.001	5.46	.001	5.47	.001	5.62	.001	5.42	.000	5.41	.000	5.42	.000	5.57	.000	5.47	.000
-14	5.52	.001	5.39	.001	5.50	.001	5.51	.001	5.46	.001	5.46	.001	5.61	.001	5.42	.000	5.42	.000	5.42	.000	5.57	.000	5.47	.000
-13	5.53	.001	5.39	.001	5.52	.001	5.51	.001	5.46	.001	5.46	.001	5.60	.001	5.42	.000	5.37	.000	5.42	.000	5.58	.000	5.48	.000
-12	5.50	.001	5.38	.001	5.60	.001	5.51	.001	5.46	.001	5.46	.001	5.60	.001	5.42	.000	5.41	.000	5.42	.000	5.59	.000	5.48	.000
-11	5.45	.001	5.40	.001	5.60	.001	5.52	.001	5.47	.001	5.47	.001	5.58	.001	5.42	.000	5.42	.000	5.41	.000	5.59	.000	5.48	.000
-10	5.53	.001	5.40	.001	5.60	.001	5.52	.001	5.48	.001	5.46	.001	5.57	.001	5.42	.000	5.35	.000	5.42	.000	5.58	.000	5.48	.000
-9	5.53	.001	5.39	.001	5.61	.001	5.51	.001	5.47	.001	5.46	.001	5.56	.001	5.43	.000	5.42	.000	5.42	.000	5.57	.000	5.46	.000
-8	5.53	.001	5.39	.001	5.60	.001	5.50	.001	5.47	.001	5.46	.001	5.55	.001	5.43	.000	5.42	.000	5.43	.000	5.56	.000	5.49	.000
-7	5.53	.001	5.39	.001	5.59	.001	5.49	.001	5.47	.001	5.46	.001	5.55	.001	5.43	.000	5.41	.000	5.43	.000	5.53	.000	5.49	.000
-6	5.52	.001	5.39	.001	5.59	.001	5.49	.001	5.47	.001	5.46	.001	5.54	.001	5.43	.000	5.38	.000	5.43	.000	5.57	.000	5.50	.000
-5	5.52	.001	5.38	.001	5.59	.001	5.43	.001	5.45	.001	5.46	.001	5.54	.001	5.43	.000	5.39	.002	5.42	.000	5.56	.000	5.51	.000
-4	5.52	.001	5.39	.001	5.58	.001	5.47	.001	5.45	.010	5.46	.001	5.53	.003	5.42	.000	5.38	2.82	5.32	.000	5.53	.000	5.51	.000
-3	5.52	.001	5.37	.001	5.58	.001	5.51	.001	5.44	4.91	5.46	.001	5.54	.007	5.43	.000	5.45	5.36	5.43	.000	5.16	.000	5.52	.000
-2	5.53	.003	5.39	.001	5.55	.001	5.45	.001	5.51	5.51	5.46	.001	5.57	.008	5.39	.000	5.44	5.43	5.42	.000	3.63	.000	5.52	.000
-1	5.52	2.96	5.40	.001	5.56	.001	5.50	.001	5.51	5.52	5.45	.001	5.58	.008	5.41	.000	5.45	5.46	5.42	.000	1.30	.000	5.52	.000
0	5.56	5.48	5.40	.001	5.55	.005	5.52	.001	5.52	5.52	5.45	.001	5.57	.008	5.43	.000	5.48	5.48	5.42	.000	.( )	.000	5.53	.000

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER TWO'S LAMP VOLTAGE (INTERFERENCE: F1 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 ON AND F2 OFF							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	5.38	.001	5.37	.001	4.92	.001	5.48	.001	5.45	.001	5.43	.001	5.48	.000	5.32	.000	5.46	.000	5.41	.000	5.51	.000	5.50	.000		
-40	5.46	.001	5.42	.001	5.37	.001	5.54	.001	5.52	.001	5.46	.001	5.54	.000	5.45	.000	5.48	.000	5.46	.000	5.53	.000	5.57	.000		
-35	5.44	.001	5.40	.001	5.32	.001	5.50	.001	5.48	.001	5.44	.001	5.51	.000	5.43	.000	5.45	.000	5.43	.000	5.50	.000	5.53	.000		
-30	5.44	.001	5.38	.001	5.34	.001	5.49	.001	5.47	.001	5.43	.001	5.41	.000	5.43	.000	5.45	.000	5.43	.000	5.50	.000	5.54	.000		
-25	5.44	.001	5.39	.001	5.33	.001	5.49	.001	5.47	.001	5.43	.001	5.25	.000	5.43	.000	5.44	.000	5.42	.000	5.50	.000	5.51	.000		
-20	5.43	.001	5.38	.001	5.35	.001	5.49	.001	5.48	.001	5.43	.001	5.48	.000	5.43	.000	5.44	.000	5.42	.000	5.50	.000	5.53	.000		
-15	5.44	.001	5.39	.001	5.36	.001	5.49	.001	5.48	.001	5.43	.001	5.49	.000	5.43	.000	5.44	.000	5.42	.000	5.49	.000	5.53	.000		
-14	5.44	.001	5.39	.001	5.36	.001	5.49	.001	5.48	.001	5.43	.001	5.51	.000	5.44	.000	5.44	.000	5.42	.000	5.50	.000	5.53	.000		
-13	5.44	.001	5.40	.001	5.36	.001	5.48	.001	5.48	.001	5.43	.001	5.50	.000	5.43	.000	5.44	.000	5.42	.000	5.50	.000	5.49	.000		
-12	5.45	.001	5.37	.001	5.37	.001	5.48	.001	5.47	.001	5.42	.001	5.47	.000	5.44	.000	5.43	.000	5.42	.000	5.49	.000	5.53	.000		
-11	5.46	.001	5.37	.001	5.37	.001	5.47	.001	5.49	.001	5.43	.001	5.51	.000	5.44	.000	5.43	.000	5.42	.000	5.46	.000	5.52	.000		
-10	5.45	.001	5.34	.001	5.38	.001	5.47	.001	5.46	.001	5.43	.001	5.56	.000	5.45	.000	5.43	.000	5.41	.000	5.46	.000	5.52	.000		
-9	5.46	.001	5.37	.001	5.39	.001	5.42	.001	5.47	.001	5.42	.001	5.59	.000	5.45	.000	5.43	.000	5.41	.000	5.49	.000	5.52	.000		
-8	5.46	.001	5.41	.001	5.39	.001	5.47	.001	5.46	.001	5.42	.001	5.57	.000	5.45	.000	5.43	.000	5.40	.000	5.49	.000	5.53	.000		
-7	5.47	.001	5.41	.001	5.40	.001	5.48	.001	5.46	.001	5.42	.001	5.59	.000	5.45	.000	5.42	.000	5.41	.000	5.49	.000	5.52	.000		
-6	5.47	.001	5.41	.001	5.39	.001	5.47	.001	5.46	.001	5.42	.001	5.58	.000	5.45	.000	5.41	.000	5.41	.000	5.49	.000	5.52	.000		
-5	5.47	.001	5.35	.001	5.40	.001	5.45	.001	5.46	.001	5.43	.001	5.57	.000	5.46	.000	5.41	.000	5.42	.000	5.49	.000	5.45	.000		
-4	5.47	.001	5.41	.001	5.37	.001	5.44	.001	5.46	.001	5.41	.001	5.37	.000	5.46	.000	5.41	.000	5.42	.000	5.48	.000	5.52	.000		
-3	5.48	.001	5.40	.001	5.38	.001	5.45	.001	5.46	.001	5.43	.001	5.57	.000	5.45	.000	5.42	.000	5.41	.000	5.44	.000	5.52	.000		
-2	5.28	.001	5.41	.001	5.40	.001	5.46	.001	5.45	.001	5.42	.001	5.57	.000	5.46	.000	5.41	.000	5.41	.000	5.22	.000	5.52	.000		
-1	5.47	.001	5.42	.001	5.41	.001	5.46	.001	5.45	.001	5.42	.001	5.56	.000	5.46	.000	5.42	.000	5.41	.000	4.41	.000	5.53	.000		
0	5.47	.001	5.43	.001	5.41	.001	5.46	.001	5.45	.005	5.42	.001	5.57	.001	5.46	.000	5.39	.057	5.41	.000	1.90	.000	5.52	.000		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER TWO'S LAMP VOLTAGE (INTERFERENCE: F2 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 OFF AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	5.43	.001	5.40	.001	5.38	.001	5.45	.001	5.42	.001	5.39	.001	5.54	.001	5.45	.000	5.13	.000	5.37	.000	5.45	.000	5.52	.000		
-40	5.50	.001	5.42	.001	5.40	.001	5.50	.001	5.47	.001	5.43	.001	5.53	.001	5.50	.000	5.25	.000	5.43	.000	5.51	.000	5.56	.000		
-35	5.47	.001	5.41	.001	5.39	.001	5.45	.001	5.46	.001	5.41	.001	5.50	.001	5.48	.000	5.23	.000	5.41	.000	5.50	.000	5.53	.000		
-30	5.47	.001	5.41	.001	5.38	.001	5.46	.001	5.46	.001	5.41	.001	5.49	.001	5.48	.000	5.24	.000	5.41	.000	5.49	.000	5.47	.000		
-25	5.47	.001	5.41	.001	5.37	.001	5.47	.001	5.46	.001	5.41	.001	5.46	.001	5.48	.000	5.25	.000	5.41	.000	5.48	.000	5.53	.000		
-20	5.47	.001	5.41	.001	5.37	.001	5.47	.001	5.44	.001	5.42	.001	5.46	.001	5.47	.000	5.25	.000	5.40	.000	5.48	.000	5.52	.000		
-15	5.46	.001	5.37	.001	5.37	.001	5.47	.001	5.43	.001	5.42	.001	5.44	.001	5.47	.000	5.25	.000	5.40	.000	5.48	.000	5.53	.000		
-14	5.46	.001	5.41	.001	5.37	.001	5.47	.001	5.45	.001	5.42	.001	5.45	.001	5.46	.000	5.26	.000	5.41	.000	5.47	.000	5.53	.000		
-13	5.46	.001	5.38	.001	5.37	.001	5.47	.001	5.45	.001	5.42	.001	5.45	.001	5.47	.000	5.27	.000	5.41	.000	5.47	.000	5.53	.000		
-12	5.46	.001	5.41	.001	5.37	.001	5.47	.001	5.42	.001	5.42	.001	5.45	.001	5.47	.000	5.27	.000	5.41	.000	5.47	.000	5.52	.000		
-11	5.46	.001	5.31	.001	5.38	.001	5.46	.001	5.45	.001	5.42	.001	5.46	.001	5.47	.000	5.28	.000	5.41	.000	5.47	.000	5.53	.000		
-10	5.46	.001	5.39	.001	5.38	.001	5.46	.001	5.45	.001	5.42	.001	5.45	.001	5.46	.000	5.29	.000	5.41	.000	5.46	.000	5.51	.000		
-9	5.46	.001	5.40	.001	5.38	.001	5.45	.001	5.45	.001	5.42	.001	5.44	.001	5.46	.000	5.30	.000	5.40	.000	5.44	.000	5.52	.000		
-8	5.46	.001	5.41	.001	5.39	.001	5.45	.001	5.44	.001	5.41	.001	5.45	.001	5.47	.000	5.31	.000	5.40	.000	5.46	.000	5.52	.000		
-7	5.46	.001	5.37	.001	5.39	.001	5.45	.001	5.43	.001	5.41	.001	5.46	.001	5.46	.000	5.31	.000	5.40	.000	5.47	.000	5.51	.000		
-6	5.45	.001	5.41	.001	5.39	.001	5.45	.001	5.39	.001	5.42	.001	5.46	.001	5.46	.000	5.32	.000	5.40	.000	5.46	.000	5.51	.000		
-5	5.46	.001	5.41	.001	5.39	.001	5.45	.001	5.39	.001	5.42	.001	5.46	.001	5.46	.000	5.33	.000	5.41	.000	5.46	.000	5.50	.000		
-4	5.46	.001	5.40	.001	5.39	.001	5.45	.001	5.43	.001	5.42	.001	5.45	.001	5.46	.000	5.34	.000	5.40	.000	5.45	.000	5.50	.000		
-3	5.46	.001	5.40	.001	5.35	.001	5.45	.001	5.40	.001	5.42	.001	5.46	.001	5.48	.000	5.33	.000	5.40	.000	5.44	.000	5.50	.000		
-2	5.46	.001	5.40	.001	5.39	.001	5.45	.001	5.39	.001	5.42	.001	5.46	.001	5.48	.000	5.33	.000	5.40	.000	5.35	.000	5.49	.000		
-1	5.44	.001	5.41	.001	5.36	.001	5.45	.001	5.38	.001	5.42	.001	5.46	.001	5.48	.000	5.32	.001	5.40	.000	2.72	.000	5.47	.000		
0	5.44	.001	5.40	.001	5.39	.001	5.45	.001	5.41	.013	5.42	.001	5.46	.001	5.47	.000	5.32	.152	5.41	.000	.184	.000	5.51	.000		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER THREE'S LAMP VOLTAGE (INTERFERENCE: F1 AND F2)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	.024	.014	.024	.014	.023	.015	.023	.012	.032	.014	.033	.014	.027	.015	.032	.012	.026	.013	.027	.014	.031	.015	.026	.011
-40	.023	.014	.024	.014	.023	.015	.022	.012	.032	.014	.032	.014	.027	.015	.032	.012	.026	.013	.027	.014	.031	.015	.026	.011
-35	.023	.014	.024	.014	.023	.015	.022	.012	.031	.014	.033	.014	.027	.015	.032	.012	.026	.013	.027	.014	.031	.015	.026	.011
-30	.023	.014	.024	.014	.023	.015	.022	.012	.031	.015	.032	.014	.026	.015	.031	.012	.026	.014	.027	.014	.031	.015	.025	.011
-25	.023	.015	.023	.015	.023	.015	.022	.012	.031	.016	.031	.014	.026	.015	.030	.012	.025	.015	.027	.014	.030	.016	.025	.012
-20	.022	.017	.022	.016	.023	.017	.020	.013	.029	.020	.028	.016	.025	.017	.028	.013	.025	.017	.026	.015	.029	.019	.023	.012
-15	.021	.019	.020	.017	.024	.018	.018	.013	.029	.023	.025	.018	.025	.019	.023	.013	.022	.020	.024	.016	.028	.021	.020	.012
-14	.021	.020	.020	.017	.024	.018	.017	.013	.025	.024	.024	.018	.025	.019	.021	.012	.025	.021	.021	.017	.028	.021	.018	.012
-13	.021	.020	.020	.017	.024	.019	.016	.012	.027	.024	.023	.018	.025	.019	.019	.012	.022	.021	.024	.017	.028	.022	.017	.012
-12	.021	.020	.019	.017	.024	.019	.015	.012	.026	.024	.022	.018	.025	.020	.017	.012	.021	.021	.017	.017	.028	.022	.015	.012
-11	.022	.020	.018	.016	.024	.019	.014	.012	.027	.024	.020	.018	.025	.020	.015	.012	.024	.022	.017	.017	.028	.023	.014	.012
-10	.020	.019	.018	.017	.024	.019	.013	.012	.023	.021	.021	.019	.025	.020	.014	.012	.019	.020	.018	.018	.028	.023	.013	.012
-9	.020	.018	.018	.017	.024	.019	.013	.012	.024	.021	.020	.019	.025	.020	.013	.012	.019	.019	.018	.018	.028	.023	.013	.012
-8	.020	.018	.018	.017	.024	.019	.012	.012	.023	.020	.020	.020	.025	.020	.013	.012	.018	.019	.017	.018	.028	.023	.012	.012
-7	.019	.018	.017	.017	.024	.019	.012	.012	.023	.020	.020	.020	.025	.020	.012	.012	.017	.019	.017	.018	.028	.024	.012	.012
-6	.019	.017	.017	.017	.024	.019	.012	.012	.022	.020	.020	.020	.024	.020	.012	.012	.018	.018	.018	.018	.028	.024	.012	.012
-5	.023	.017	.018	.017	.024	.019	.012	.012	.023	.019	.021	.020	.025	.020	.012	.012	.016	.018	.018	.018	.028	.024	.012	.012
-4	.020	.017	.018	.017	.024	.019	.012	.012	.021	.019	.020	.020	.025	.020	.012	.012	.023	.017	.019	.019	.028	.024	.012	.012
-3	.023	.016	.018	.018	.025	.019	.012	.012	.019	.018	.020	.021	.025	.020	.012	.012	.019	.017	.018	.019	.028	.024	.012	.012
-2	.019	.016	.018	.018	.025	.019	.012	.012	.019	.018	.021	.021	.025	.020	.012	.012	.020	.017	.019	.019	.028	.024	.012	.011
-1	.023	.016	.018	.018	.024	.019	.012	.012	.018	.017	.021	.021	.025	.020	.012	.012	.015	.016	.019	.019	.028	.024	.012	.012
0	.021	.015	.018	.018	.024	.019	.012	.012	.018	.017	.021	.021	.024	.020	.012	.012	.019	.016	.019	.019	.028	.024	.012	.012

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER THREE'S LAMP VOLTAGE (INTERFERENCE: F1 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 ON AND F2 OFF							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	.024	.014	.023	.014	.025	.016	.022	.012	.032	.014	.033	.014	.032	.015	.031	.011	.026	.013	.027	.014	.027	.016	.025	.011		
-40	.024	.014	.024	.014	.025	.016	.022	.012	.032	.014	.033	.014	.032	.015	.031	.011	.026	.013	.027	.014	.027	.016	.025	.011		
-35	.024	.014	.024	.014	.025	.016	.022	.012	.031	.014	.033	.014	.032	.015	.031	.011	.026	.013	.027	.014	.027	.016	.025	.011		
-30	.023	.014	.024	.014	.024	.016	.022	.012	.031	.014	.032	.014	.032	.015	.031	.011	.026	.013	.027	.014	.026	.016	.025	.011		
-25	.023	.014	.023	.014	.024	.016	.021	.012	.030	.014	.031	.014	.031	.016	.029	.011	.025	.013	.026	.014	.026	.016	.024	.011		
-20	.021	.015	.021	.014	.023	.016	.020	.012	.028	.015	.028	.014	.029	.017	.026	.011	.023	.014	.022	.014	.024	.017	.022	.011		
-15	.019	.015	.019	.016	.022	.016	.016	.012	.023	.015	.023	.018	.026	.017	.018	.011	.020	.014	.018	.016	.022	.018	.016	.011		
-14	.019	.015	.018	.017	.021	.016	.015	.012	.021	.014	.022	.019	.025	.018	.016	.011	.020	.014	.022	.017	.022	.018	.015	.011		
-13	.018	.015	.018	.017	.021	.017	.014	.012	.020	.015	.022	.020	.025	.018	.015	.011	.019	.014	.018	.018	.022	.018	.013	.011		
-12	.017	.015	.019	.018	.020	.017	.013	.012	.020	.015	.022	.022	.025	.019	.013	.011	.016	.014	.019	.019	.022	.019	.013	.011		
-11	.017	.015	.019	.019	.021	.019	.013	.012	.019	.015	.023	.023	.025	.020	.012	.011	.019	.014	.018	.020	.022	.020	.012	.011		
-10	.017	.016	.019	.019	.021	.019	.012	.012	.019	.017	.024	.025	.024	.021	.012	.011	.017	.016	.020	.021	.022	.020	.011	.011		
-9	.017	.016	.019	.020	.021	.020	.012	.012	.019	.018	.025	.025	.026	.023	.011	.011	.019	.017	.022	.022	.022	.021	.011	.011		
-8	.018	.017	.020	.020	.022	.021	.012	.012	.021	.020	.025	.026	.026	.024	.011	.011	.019	.018	.021	.022	.023	.022	.011	.011		
-7	.018	.018	.020	.020	.022	.022	.012	.012	.021	.021	.026	.026	.027	.026	.011	.011	.019	.019	.022	.022	.024	.023	.011	.011		
-6	.019	.018	.020	.020	.022	.023	.012	.012	.022	.022	.026	.026	.028	.028	.011	.011	.017	.019	.022	.023	.024	.024	.011	.011		
-5	.019	.019	.020	.020	.024	.024	.012	.012	.023	.023	.026	.026	.029	.030	.011	.011	.021	.020	.023	.023	.025	.025	.011	.011		
-4	.019	.019	.020	.020	.025	.025	.012	.012	.024	.024	.026	.026	.030	.031	.011	.011	.021	.020	.023	.023	.025	.026	.011	.011		
-3	.019	.019	.020	.020	.025	.026	.012	.012	.024	.024	.026	.027	.031	.032	.011	.011	.019	.021	.023	.023	.026	.026	.011	.011		
-2	.019	.020	.020	.020	.026	.027	.012	.012	.024	.025	.026	.026	.031	.033	.011	.011	.021	.021	.023	.023	.026	.027	.011	.011		
-1	.020	.020	.020	.020	.026	.027	.012	.012	.024	.025	.026	.026	.032	.033	.011	.011	.021	.021	.023	.023	.026	.027	.011	.011		
0	.019	.020	.020	.020	.027	.028	.012	.012	.024	.025	.026	.026	.033	.034	.011	.011	.020	.020	.023	.023	.026	.027	011	.011		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER THREE'S LAMP VOLTAGE (INTERFERENCE: F2 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 OFF AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	.023	.014	.023	.014	.024	.013	.022	.012	.031	.014	.032	.014	.026	.013	.031	.011	.026	.013	.027	.014	.031	.013	.025	.011
-40	.023	.014	.023	.014	.024	.013	.022	.012	.031	.014	.032	.014	.026	.013	.031	.011	.026	.013	.028	.014	.031	.013	.025	.011
-35	.023	.014	.023	.014	.024	.013	.022	.012	.031	.014	.032	.014	.026	.013	.031	.011	.026	.013	.028	.014	.031	.013	.025	.011
-30	.023	.014	.023	.014	.023	.013	.022	.012	.031	.014	.032	.014	.026	.013	.031	.011	.027	.014	.027	.014	.030	.013	.025	.011
-25	.023	.015	.023	.014	.024	.014	.022	.012	.031	.016	.032	.014	.027	.013	.031	.011	.027	.015	.027	.014	.030	.014	.025	.011
-20	.025	.018	.023	.014	.024	.016	.022	.012	.032	.022	.031	.014	.027	.016	.030	.011	.029	.019	.027	.014	.031	.018	.025	.011
-15	.026	.021	.021	.014	.026	.022	.018	.012	.031	.027	.029	.014	.028	.022	.024	.011	.030	.025	.027	.014	.031	.024	.021	.011
-14	.025	.022	.020	.014	.027	.023	.017	.012	.032	.028	.026	.014	.028	.023	.021	.011	.025	.025	.024	.014	.032	.025	.019	.011
-13	.025	.022	.018	.014	.027	.024	.015	.012	.030	.028	.023	.014	.026	.024	.019	.011	.015	.026	.022	.014	.032	.027	.017	.011
-12	.025	.022	.017	.014	.026	.024	.014	.012	.030	.028	.021	.014	.029	.025	.016	.011	.023	.026	.020	.014	.033	.028	.015	.011
-11	.022	.021	.015	.014	.025	.025	.013	.012	.029	.026	.018	.014	.029	.025	.014	.011	.020	.024	.017	.014	.033	.028	.013	.011
-10	.024	.021	.015	.014	.027	.025	.012	.012	.028	.026	.017	.014	.030	.026	.013	.011	.031	.024	.016	.014	.033	.029	.012	.011
-9	.024	.021	.015	.014	.027	.026	.012	.012	.029	.026	.016	.014	.027	.026	.012	.011	.029	.024	.016	.014	.033	.029	.012	.011
-8	.022	.021	.014	.014	.031	.026	.012	.012	.027	.026	.015	.014	.030	.026	.012	.011	.031	.024	.015	.014	.034	.030	.012	.011
-7	.022	.021	.015	.014	.030	.026	.012	.012	.028	.025	.015	.014	.030	.026	.012	.011	.019	.023	.015	.014	.034	.030	.011	.011
-6	.026	.021	.014	.014	.031	.026	.012	.012	.026	.025	.015	.015	.029	.027	.011	.011	.030	.023	.015	.014	.034	.030	.011	.011
-5	.024	.021	.014	.014	.031	.026	.012	.012	.023	.024	.015	.015	.028	.027	.011	.011	.016	.022	.015	.015	.034	.030	.011	.011
-4	.025	.021	.015	.014	.026	.026	.012	.012	.024	.023	.015	.015	.024	.027	.011	.011	.016	.022	.015	.015	.034	.030	.011	.011
-3	.026	.020	.014	.014	.027	.027	.012	.012	.023	.023	.015	.015	.026	.027	.011	.011	.029	.021	.015	.015	.034	.031	.011	.011
-2	.022	.020	.015	.014	.031	.027	.012	.012	.022	.022	.015	.015	.030	.027	.011	.011	.026	.021	.015	.015	.034	.031	.011	.011
-1	.022	.020	.014	.014	.026	.027	.012	.012	.021	.021	.015	.015	.029	.027	.011	.011	.016	.020	.015	.015	.034	.031	.011	.011
0	.023	.019	.014	.014	.027	.027	.012	.012	.020	.021	.015	.015	.031	.027	.011	.011	.014	.019	.015	.015	.034	.031	.011	.011

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FOUR'S LAMP VOLTAGE (INTERFERENCE: F1 AND F2)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	.242	.013	.233	.014	.236	.015	.242	.011	.350	.013	.350	.013	.353	.015	.349	.011	.423	.013	.428	.014	.421	.015	.417	.009
-40	.241	.013	.233	.014	.236	.015	.237	.011	.350	.013	.350	.013	.352	.015	.346	.009	.421	.013	.426	.014	.421	.015	.417	.009
-35	.241	.013	.233	.014	.236	.015	.236	.011	.350	.013	.350	.013	.352	.015	.346	.009	.421	.013	.426	.014	.421	.015	.417	.009
-30	.241	.013	.233	.014	.236	.015	.236	.011	.350	.013	.350	.013	.352	.015	.346	.009	.421	.013	.426	.014	.421	.015	.417	.009
-25	.240	.013	.233	.014	.237	.015	.236	.011	.350	.013	.350	.013	.352	.015	.346	.010	.421	.013	.426	.014	.421	.015	.417	.009
-20	.240	.013	.233	.014	.237	.015	.236	.011	.350	.013	.350	.013	.351	.015	.346	.009	.421	.013	.426	.014	.420	.299	.417	.009
-15	.240	.013	.233	.014	.247	.015	.235	.011	.350	.013	.350	.013	.349	.017	.346	.009	.421	.013	.426	.014	.421	.301	.417	.009
-14	.239	.013	.233	.014	.245	.015	.235	.011	.350	.013	.350	.013	.348	.019	.346	.010	.421	.013	.426	.014	.422	.302	.417	.009
-13	.239	.013	.233	.014	.240	.015	.235	.011	.350	.013	.350	.013	.348	.017	.346	.010	.421	.013	.426	.014	.421	.301	.417	.009
-12	.239	.013	.233	.014	.246	.015	.235	.011	.350	.013	.350	.013	.348	.017	.346	.010	.421	.013	.426	.014	.422	.298	.417	.009
-11	.238	.013	.232	.014	.248	.015	.235	.011	.350	.013	.350	.013	.343	.017	.346	.010	.422	.013	.427	.014	.423	.293	.417	.009
-10	.238	.013	.232	.014	.254	.015	.235	.011	.351	.013	.350	.013	.334	.017	.346	.009	.422	.013	.428	.014	.417	.288	.417	.009
-9	.238	.013	.232	.014	.253	.015	.234	.011	.351	.013	.350	.013	.320	.017	.346	.010	.422	.013	.428	.014	.404	.281	.417	.009
-8	.238	.013	.232	.014	.250	.015	.234	.011	.351	.013	.350	.013	.300	.017	.346	.010	.422	.013	.428	.014	.399	.260	.417	.009
-7	.237	.013	.232	.014	.255	.015	.234	.011	.351	.013	.350	.013	.297	.017	.346	.010	.422	.013	.428	.014	.388	.236	.417	.009
-6	.237	.013	.232	.014	.251	.015	.234	.011	.351	.013	.350	.013	.279	.017	.346	.010	.422	.013	.428	.014	.371	.207	.417	.009
-5	.237	.013	.232	.014	.249	.015	.234	.011	.351	.013	.350	.013	.287	.017	.346	.010	.422	.013	.428	.014	.367	.192	.417	.009
-4	.237	.013	.232	.014	.257	.015	.234	.011	.351	.013	.350	.013	.289	.018	.346	.010	.422	.013	.428	.014	.343	.176	.417	.009
-3	.237	.013	.232	.014	.256	.015	.234	.011	.351	.013	.350	.013	.269	.018	.346	.010	.422	.013	.428	.014	.315	.175	.417	.009
-2	.236	.013	.232	.014	.221	.015	.233	.011	.351	.013	.350	.013	.244	.018	.346	.010	.422	.013	.428	.014	.285	.176	.417	.009
-1	.236	.013	.232	.014	.246	.015	.233	.011	.351	.013	.350	.013	.251	.018	.346	.010	.422	.013	.427	.014	.255	.174	.417	.009
0	.236	.013	.232	.014	.237	.015	.233	.011	.351	.013	.350	.013	.212	.018	.346	.010	.421	.013	.427	.014	.212	.173	.417	.009

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FOUR'S LAMP VOLTAGE (INTERFERENCE: F1 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 ON AND F2 OFF							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	.233	.013	.232	.014	.234	.014	.241	.011	.372	.013	.377	.014	.356	.014	.350	.010	.421	.013	.427	.014	.445	.015	.418	.010		
-40	.233	.013	.232	.014	.234	.014	.239	.011	.368	.013	.368	.014	.355	.014	.349	.010	.421	.013	.426	.014	.440	.015	.418	.010		
-35	.233	.013	.232	.014	.234	.014	.238	.011	.367	.013	.368	.014	.355	.014	.349	.010	.421	.013	.426	.014	.440	.015	.418	.010		
-30	.233	.013	.232	.014	.235	.014	.238	.011	.367	.013	.367	.014	.356	.014	.350	.010	.421	.013	.426	.014	.439	.015	.418	.010		
-25	.233	.013	.232	.014	.235	.014	.238	.011	.366	.013	.367	.014	.355	.014	.350	.010	.421	.013	.426	.014	.438	.015	.418	.010		
-20	.233	.013	.232	.014	.237	.014	.238	.011	.365	.013	.366	.014	.354	.014	.350	.010	.421	.013	.426	.014	.437	.015	.418	.010		
-15	.233	.013	.232	.014	.242	.014	.237	.011	.364	.013	.365	.014	.352	.014	.350	.010	.421	.013	.426	.014	.437	.322	.418	.010		
-14	.233	.013	.232	.014	.241	.014	.237	.011	.364	.013	.365	.014	.352	.015	.350	.010	.421	.013	.426	.014	.436	.319	.418	.010		
-13	.233	.013	.232	.014	.243	.014	.237	.011	.363	.013	.364	.014	.350	.016	.349	.010	.421	.013	.426	.014	.435	.317	.418	.010		
-12	.233	.013	.232	.014	.235	.014	.237	.011	.362	.013	.364	.014	.353	.016	.349	.010	.421	.013	.426	.014	.434	.317	.418	.010		
-11	.233	.013	.232	.014	.243	.014	.236	.011	.362	.013	.363	.014	.351	.016	.349	.010	.421	.013	.426	.014	.433	.315	.418	.010		
-10	.233	.013	.232	.014	.246	.014	.236	.011	.362	.013	.364	.014	.349	.016	.350	.010	.421	.013	.426	.014	.433	.312	.418	.010		
-9	.233	.013	.232	.014	.247	.014	.236	.011	.361	.013	.363	.014	.346	.016	.350	.010	.421	.013	.426	.014	.433	.309	.418	.010		
-8	.233	.013	.232	.014	.261	.014	.236	.010	.361	.013	.363	.014	.343	.016	.349	.010	.421	.013	.426	.014	.433	.305	.418	.010		
-7	.233	.013	.232	.014	.254	.014	.236	.011	.360	.013	.363	.014	.341	.017	.349	.010	.421	.013	.426	.014	.437	.300	.418	.010		
-6	.233	.013	.232	.014	.255	.014	.235	.011	.360	.013	.362	.014	.331	.017	.349	.010	.421	.013	.426	.014	.440	.290	.418	.010		
-5	.233	.013	.232	.014	.250	.014	.235	.011	.359	.013	.362	.014	.269	.017	.349	.010	.421	.013	.426	.014	.420	.274	.418	.010		
-4	.233	.013	.232	.014	.255	.014	.235	.011	.359	.013	.362	.014	.267	.014	.349	.010	.421	.013	.426	.014	.391	.244	.418	.010		
-3	.233	.013	.232	.014	.254	.014	.235	.011	.358	.013	.361	.014	.245	.014	.349	.010	.421	.013	.426	.014	.360	.212	.418	.010		
-2	.233	.013	.232	.014	.246	.014	.235	.011	.358	.013	.361	.014	.239	.017	.349	.010	.421	.013	.426	.014	.343	.159	.418	.010		
-1	.233	.013	.232	.014	.256	.014	.235	.011	.358	.013	.361	.014	.200	.017	.349	.010	.421	.013	.427	.014	.307	.032	.418	.010		
0	.233	.013	.232	.014	.239	.014	.235	.011	.357	.013	.361	.014	.229	.017	.350	.010	.421	.013	.427	.014	.281	.078	.418	.010		

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FOUR'S LAMP VOLTAGE (INTERFERENCE: F2 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VAC) (Outer Marker Mode) 400 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VAC) (Middle Marker Mode) 1300 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VAC) (Inner Marker Mode) 3000 Hertz Interference F1 OFF AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	un	off	on	off	on	off	on	off	on	off
Baseline	.233	.013	.232	.014	.241	.013	.234	.011	.355	.013	.359	.014	.358	.013	.350	.010	.421	.013	.426	.014	.422	.013	.418	.010
-40	.233	.013	.232	.014	.240	.013	.234	.011	.353	.013	.357	.014	.356	.013	.349	.010	.420	.013	.425	.014	.423	.013	.417	.010
-35	.233	.013	.232	.014	.240	.013	.233	.011	.353	.013	.357	.014	.355	.013	.349	.010	.420	.013	.425	.014	.423	.013	.417	.010
-30	.233	.013	.232	.014	.240	.013	.233	.011	.353	.013	.357	.014	.355	.013	.349	.010	.421	.013	.425	.014	.423	.013	.418	.010
-25	.233	.013	.232	.014	.240	.013	.233	.011	.353	.013	.357	.014	.355	.013	.349	.010	.421	.013	.425	.014	.423	.013	.418	.010
-20	.233	.013	.232	.014	.241	.013	.233	.011	.353	.013	.357	.014	.356	.013	.349	.010	.421	.013	.425	.014	.423	.013	.418	.010
-15	.233	.013	.232	.014	.245	.013	.233	.011	.353	.013	.357	.014	.356	.013	.349	.010	.421	.013	.425	.014	.423	.257	.418	.010
-14	.233	.013	.232	.014	.243	.013	.233	.011	.353	.013	.357	.014	.351	.013	.349	.010	.421	.013	.425	.014	.423	.249	.418	.010
-13	.233	.013	.232	.014	.244	.013	.233	.011	.353	.013	.357	.014	.350	.013	.349	.010	.420	.013	.425	.014	.423	.249	.417	.010
-12	.233	.013	.232	.014	.246	.013	.233	.011	.353	.013	.357	.014	.357	.015	.349	.010	.420	.013	.425	.014	.423	.247	.417	.010
-11	.233	.013	.232	.014	.237	.013	.233	.011	.353	.013	.357	.014	.344	.070	.349	.010	.421	.013	.426	.014	.423	.242	.418	.010
-10	.233	.013	.232	.014	.244	.013	.233	.011	.353	.013	.357	.014	.351	.084	.349	.011	.421	.013	.426	.014	.423	.242	.418	.010
-9	.233	.013	.232	.014	.244	.013	.233	.011	.353	.013	.357	.014	.349	.082	.349	.010	.421	.013	.426	.014	.424	.231	.418	.010
-8	.233	.013	.232	.014	.251	.013	.233	.011	.353	.013	.357	.014	.353	.048	.349	.010	.421	.013	.425	.014	.425	.219	.418	.010
-7	.233	.013	.232	.014	.257	.013	.233	.011	.353	.013	.357	.014	.351	.016	.349	.010	.421	.013	.425	.014	.425	.211	.418	.010
-6	.233	.013	.232	.014	.266	.013	.233	.011	.353	.013	.357	.014	.346	.016	.349	.010	.421	.013	.425	.014	.425	.218	.418	.010
-5	.233	.013	.232	.014	.274	.013	.233	.011	.353	.013	.357	.014	.329	.016	.349	.011	.421	.013	.425	.014	.411	.228	.418	.010
-4	.233	.013	.232	.014	.240	.013	.233	.011	.353	.013	.357	.014	.255	.016	.349	.011	.421	.013	.425	.014	.400	.238	.418	.010
-3	.233	.013	.232	.014	.278	.013	.233	.011	.353	.013	.357	.014	.225	.016	.349	.011	.421	.013	.425	.014	.395	.235	.418	.010
-2	.233	.013	.232	.014	.246	.013	.233	.011	.352	.013	.357	.014	.211	.016	.349	.011	.421	.013	.425	.014	.385	.233	.418	.010
-1	.233	.013	.232	.014	.240	.013	.233	.011	.352	.013	.356	.014	.124	.017	.349	.011	.420	.013	.425	.014	.369	.227	.418	.010
0	.233	.013	.232	.014	.241	.013	.233	.011	.352	.013	.356	.014	.271	.017	.349	.011	.420	.013	.425	.014	.365	.205	.418	.010

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FIVE'S LAMP VOLTAGE (INTERFERENCE: F1 AND F2)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	.855	8.94	.841	8.98	.834	9.02	.863	8.96	.792	9.00	.784	9.00	.786	9.04	.800	8.95	.791	8.93	.794	9.00	.785	8.91	.808	8.96
-40	.829	8.97	.822	9.01	.826	9.03	.842	8.99	.782	9.03	.782	9.02	.785	9.04	.790	8.98	.783	8.98	.782	9.02	.784	8.95	.796	9.02
-35	.839	8.97	.829	9.00	.832	9.02	.853	8.98	.784	9.03	.783	9.01	.786	9.04	.792	8.98	.786	8.97	.785	9.02	.787	8.95	.799	9.01
-30	.839	8.97	.828	9.00	.836	9.02	.856	8.98	.785	9.02	.784	9.01	.786	9.03	.793	8.98	.786	8.97	.786	9.01	.787	8.95	.800	9.01
-25	.840	8.97	.830	9.00	.832	9.02	.854	8.97	.785	9.02	.784	9.01	.786	9.03	.793	8.98	.786	8.97	.786	9.01	.787	8.95	.800	9.01
-20	.841	8.97	.830	9.00	.834	9.02	.855	8.97	.786	9.02	.784	9.01	.787	9.03	.794	8.98	.787	8.97	.786	9.01	.788	8.95	.801	9.00
-15	.841	8.97	.830	9.00	.835	9.02	.859	8.97	.786	9.02	.785	9.01	.788	9.03	.795	8.98	.788	8.97	.787	9.01	.792	8.96	.802	9.00
-14	.840	8.97	.832	9.00	.837	9.02	.857	8.97	.787	9.02	.785	9.01	.788	9.03	.795	8.98	.788	8.97	.787	9.01	.794	8.96	.802	9.00
-13	.841	8.97	.833	9.00	.836	9.02	.857	8.97	.787	9.02	.785	9.01	.788	9.03	.795	8.98	.788	8.98	.787	9.01	.796	8.96	.803	9.00
-12	.844	8.98	.832	9.00	.837	9.02	.858	8.97	.787	9.02	.786	9.01	.789	9.03	.796	8.98	.789	8.98	.787	9.01	.798	8.96	.804	9.00
-11	.851	8.98	.838	9.00	.837	9.02	.871	8.97	.791	9.02	.789	9.01	.790	9.02	.800	8.98	.794	8.98	.792	9.01	.798	8.96	.814	9.00
-10	.856	8.98	.845	9.01	.837	9.02	.879	8.97	.796	9.02	.793	9.01	.790	9.02	.806	8.99	.798	8.98	.799	9.01	.808	8.96	.831	9.00
-9	.857	8.98	.845	9.01	.839	9.02	.883	8.97	.797	9.02	.793	9.01	.792	9.02	.807	8.99	.801	8.98	.800	9.01	.816	8.97	.835	9.00
-8	.863	8.98	.847	9.01	.840	9.02	.885	8.97	.799	9.02	.794	9.01	.793	9.02	.809	8.99	.802	8.98	.801	9.01	.809	8.97	.841	9.00
-7	.864	8.98	.850	9.01	.843	9.02	.888	8.97	.800	9.02	.795	9.01	.795	9.02	.811	8.99	.804	8.98	.803	9.01	.831	8.97	.849	9.01
-6	.872	8.98	.850	9.01	.844	9.02	.893	8.97	.804	9.02	.797	9.01	.798	9.02	.813	8.99	.818	8.98	.806	9.01	.844	8.97	.864	9.01
-5	.876	8.98	.855	9.01	.842	9.02	.899	8.97	.806	9.02	.799	9.01	.802	9.02	.817	8.99	.813	8.99	.809	9.01	.846	8.97	.894	9.01
-4	.880	8.98	.859	9.01	.854	9.02	.907	8.97	.811	9.02	.801	9.02	.806	9.02	.823	8.99	.819	8.99	.814	9.01	.880	8.97	.989	9.01
-3	.899	8.98	.864	9.01	.857	9.02	.919	8.98	.820	9.02	.805	9.02	.818	9.02	.831	8.99	1.27	8.99	.821	9.01	.939	8.97	1.18	9.01
-2	.902	8.98	.870	9.01	.858	9.02	.935	8.98	.842	9.02	.810	9.02	.830	9.02	.844	8.99	2.13	8.99	.835	9.01	1.04	8.97	1.46	9.00
-1	.933	8.99	.885	9.01	.865	9.02	.959	8.98	.992	9.02	.818	9.02	.873	9.02	.869	8.99	2.35	8.99	.889	9.01	1.33	8.97	1.80	9.00
0	.961	8.99	.910	9.01	.882	9.02	1.01	8.98	1.19	9.02	.832	9.02	1.14	9.02	.941	8.99	1.92	8.98	1.15	9.01	1.73	8.97	2.24	9.00

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FIVE'S LAMP VOLTAGE (INTERFERENCE: F1 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 ON AND F2 OFF								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 ON AND F2 OFF							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Baseline	.848	8.98	.843	9.00	.848	8.96	.867	8.97	.792	9.02	.788	8.97	.788	9.01	.804	9.00	.793	8.97	.793	8.99	.789	9.00	.825	9.00
-40	.831	9.00	.826	9.03	.834	9.00	.846	9.02	.785	9.04	.783	9.00	.786	9.03	.795	9.03	.793	9.07	.786	9.01	.788	9.01	.811	9.04
-35	.839	9.00	.834	9.02	.842	9.00	.856	9.01	.787	9.03	.784	9.00	.788	9.02	.798	9.03	.795	9.06	.788	9.01	.790	9.01	.815	9.03
-30	.841	9.00	.834	9.02	.842	8.99	.857	9.01	.788	9.03	.785	9.00	.788	9.02	.799	9.02	.796	9.05	.789	9.01	.791	9.01	.817	9.03
-25	.842	8.99	.836	9.01	.842	8.99	.860	9.01	.788	9.03	.785	9.00	.788	9.01	.799	9.02	.795	9.04	.789	9.01	.791	9.01	.818	9.03
-20	.840	8.99	.836	9.01	.844	8.99	.860	9.01	.788	9.03	.785	9.00	.789	9.01	.799	9.02	.795	9.04	.789	9.01	.792	9.01	.818	9.03
-15	.841	8.99	.834	9.01	.843	8.99	.858	9.00	.789	9.03	.785	9.00	.789	9.01	.800	9.02	.795	9.04	.790	9.01	.794	9.01	.819	9.03
-14	.840	8.99	.835	9.01	.844	8.99	.858	9.00	.788	9.03	.786	9.00	.789	9.01	.800	9.02	.795	9.04	.790	9.01	.795	9.01	.819	9.03
-13	.841	8.99	.837	9.01	.844	8.99	.860	9.00	.789	9.03	.786	9.00	.789	9.01	.800	9.02	.795	9.04	.790	9.01	.796	9.01	.819	9.03
-12	.841	9.00	.836	9.01	.845	8.99	.860	9.00	.789	9.03	.787	9.00	.789	9.01	.800	9.02	.795	9.04	.790	9.01	.797	9.01	.819	9.03
-11	.843	9.00	.837	9.01	.842	8.99	.860	9.00	.789	9.03	.787	9.00	.789	9.01	.800	9.02	.795	9.03	.790	9.01	.800	9.01	.820	9.03
-10	.850	9.00	.843	9.01	.844	8.99	.874	9.00	.793	9.03	.790	9.00	.793	9.01	.807	9.02	.802	9.03	.796	9.01	.801	9.01	.844	9.03
-9	.848	9.00	.844	9.01	.844	8.99	.869	9.01	.793	9.03	.791	9.00	.793	9.01	.808	9.02	.803	9.03	.796	9.01	.804	9.01	.846	9.03
-8	.847	9.00	.846	9.01	.845	8.99	.874	9.01	.793	9.03	.791	9.00	.794	9.01	.808	9.02	.803	9.03	.797	9.01	.807	9.01	.849	9.03
-7	.850	9.00	.843	9.01	.843	8.99	.874	9.01	.794	9.03	.791	9.00	.794	9.01	.809	9.02	.804	9.03	.797	9.01	.812	9.01	.852	9.03
-6	.853	9.00	.843	9.01	.845	8.99	.873	9.01	.794	9.03	.792	9.00	.795	9.01	.810	9.02	.806	9.03	.798	9.01	.817	9.01	.857	9.03
-5	.853	9.00	.847	9.01	.849	8.99	.880	9.01	.795	9.03	.792	9.00	.797	9.01	.811	9.02	.806	9.03	.799	9.01	.827	9.01	.865	9.03
-4	.854	9.00	.848	9.01	.848	8.99	.880	9.01	.796	9.03	.793	9.00	.804	9.01	.812	9.02	.810	9.03	.800	9.01	.837	9.01	.875	9.03
-3	.855	9.00	.850	9.01	.851	8.99	.881	9.01	.798	9.03	.794	9.00	.804	9.01	.814	9.02	.813	9.03	.802	9.01	.859	9.01	.895	9.03
-2	.858	9.00	.852	9.01	.851	8.99	.883	9.01	.799	9.03	.795	9.00	.802	9.01	.817	9.02	.819	9.03	.804	9.01	.900	9.01	.943	9.03
-1	.862	9.00	.853	9.01	.856	8.99	.889	9.01	.802	9.03	.797	9.00	.810	9.01	.821	9.02	.832	9.03	.806	9.01	1.03	9.01	1.04	9.03
0	.868	9.00	.859	9.01	.863	9.00	.896	9.01	.806	9.03	.799	9.01	.824	9.01	.826	9.02	.923	9.03	.810	9.01	1.42	9.01	1.18	9.03

DESENSITIZATION EFFECT ON MARKER RECEIVER NUMBER FIVE'S LAMP VOLTAGE (INTERFERENCE: F2 ONLY)

F1/F2 Signal Level	LAMP VOLTAGE (VDC) (Outer Marker Mode) 400 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Middle Marker Mode) 1300 Hertz Interference F1 OFF AND F2 ON								LAMP VOLTAGE (VDC) (Inner Marker Mode) 3000 Hertz Interference F1 OFF AND F2 ON							
	AM		FM		PM		CW		AM		FM		PM		CW		AM		FM		PM		CW			
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off		
Baseline	.846	8.99	.842	9.00	.853	8.96	.869	8.99	.791	9.01	.790	8.99	.790	8.94	.802	9.00	.796	9.01	.793	8.99	.787	8.89	.828	9.01		
-40	.829	9.01	.827	9.02	.832	8.97	.848	9.03	.785	9.04	.785	9.01	.787	8.96	.797	9.05	.792	9.06	.787	9.02	.783	8.93	.811	9.04		
-35	.838	9.01	.834	9.02	.840	8.97	.859	9.03	.787	9.03	.787	9.01	.788	8.96	.800	9.04	.795	9.05	.789	9.01	.785	8.93	.816	9.03		
-30	.839	9.01	.835	9.02	.844	8.97	.860	9.02	.787	9.03	.787	9.01	.789	8.96	.800	9.04	.795	9.05	.790	9.01	.787	8.94	.818	9.03		
-25	.840	9.01	.836	9.02	.844	8.97	.861	9.02	.787	9.03	.787	9.01	.788	8.96	.800	9.03	.795	9.04	.790	9.01	.787	8.94	.819	9.03		
-20	.839	9.01	.837	9.02	.837	8.97	.860	9.02	.788	9.03	.787	9.01	.789	8.96	.801	9.03	.795	9.04	.790	9.01	.787	8.94	.820	9.03		
-15	.840	9.01	.838	9.02	.847	8.97	.862	9.01	.788	9.03	.788	9.01	.789	8.96	.801	9.03	.795	9.04	.791	9.01	.788	8.94	.822	9.03		
-14	.842	9.01	.836	9.01	.844	8.97	.863	9.01	.789	9.03	.788	9.01	.789	8.96	.801	9.03	.795	9.04	.791	9.01	.789	8.94	.822	9.03		
-13	.841	9.01	.837	9.01	.840	8.97	.862	9.01	.789	9.03	.788	9.01	.789	8.96	.802	9.03	.796	9.04	.791	9.01	.790	8.94	.823	9.03		
-12	.842	9.01	.838	9.01	.849	8.98	.864	9.01	.789	9.03	.788	9.01	.790	8.97	.802	9.03	.796	9.03	.792	9.01	.790	8.94	.825	9.03		
-11	.848	9.01	.844	9.01	.848	8.98	.873	9.01	.793	9.03	.791	9.01	.791	8.97	.809	9.03	.805	9.03	.797	9.01	.791	8.95	.857	9.03		
-10	.853	9.01	.845	9.01	.844	8.98	.875	9.01	.794	9.03	.792	9.01	.792	8.97	.810	9.03	.805	9.03	.797	9.01	.792	8.95	.861	9.03		
-9	.851	9.01	.845	9.02	.840	8.98	.878	9.01	.795	9.03	.792	9.01	.792	8.97	.811	9.03	.806	9.03	.798	9.01	.794	8.95	.870	9.03		
-8	.856	9.01	.846	9.02	.854	8.98	.880	9.01	.796	9.03	.793	9.01	.792	8.97	.812	9.03	.810	9.03	.799	9.01	.796	8.95	.881	9.03		
-7	.858	9.01	.848	9.02	.856	8.98	.883	9.01	.798	9.03	.793	9.01	.793	8.97	.814	9.03	.814	9.03	.800	9.01	.802	8.95	.900	9.03		
-6	.859	9.01	.849	9.02	.838	8.98	.886	9.01	.799	9.03	.794	9.01	.794	8.97	.816	9.03	.828	9.03	.802	9.01	.800	8.95	.938	9.03		
-5	.862	9.01	.853	9.02	.834	8.98	.890	9.01	.802	9.03	.795	9.01	.792	8.97	.819	9.03	.908	9.03	.804	9.01	.806	8.95	1.01	9.03		
-4	.868	9.01	.856	9.02	.839	8.98	.895	9.01	.804	9.03	.797	9.01	.801	8.97	.823	9.03	1.10	9.03	.807	9.01	.811	8.95	1.12	9.03		
-3	.874	9.01	.857	9.02	.871	8.98	.906	9.01	.812	9.03	.799	9.01	.809	8.97	.829	9.03	1.23	9.03	.811	9.01	.815	8.95	1.26	9.03		
-2	.885	9.01	.865	9.02	.871	8.98	.911	9.01	.818	9.03	.801	9.01	.806	8.97	.838	9.03	1.83	9.03	.816	9.01	.840	8.95	1.44	9.03		
-1	.902	9.01	.872	9.02	.848	8.98	.929	9.01	.865	9.03	.805	9.01	.818	8.97	.853	9.03	1.79	9.03	.825	9.01	.937	8.96	1.67	9.03		
0	.925	9.01	.879	9.02	.884	8.98	.955	9.01	1.09	9.03	.810	9.01	.802	8.97	.883	9.03	2.57	9.02	.859	9.01	1.52	8.96	1.95	9.03		